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Education and Investor Behaviour

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Declaration:
Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any other academic degree.

Kristjan Liivamägi
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KRISTJAN LIIVAMÄGI

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Paper I – The author of the thesis is the sole author of the article.

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INTRODUCTION

Behavioural finance is defined by Shefrin (2002) as the application of psychology to financial behaviour. Behavioural finance gained wider popularity among academics after Kahneman and Tversky (1979) presented a critique of expected utility theory and developed a prospect theory model. Since then behavioural finance has garnered ever more interest and has been widely researched by academics. The debate is still ongoing over whether investors are rational and the efficient market hypothesis presented by Fama (1970) applies, or whether they tend to be affected by emotions and psychological biases.

Fama (1998) is convinced that the efficient market hypothesis is the most appropriate model for describing financial markets and that bubbles and busts in the stock market are overreactions and under-reactions to information and tend to disappear in the long run. According to Fama (1970) there are three forms of efficient market:

- The weak form states that all past market prices and data are fully reflected in securities prices.
- The semi strong form states that all publicly available information is fully reflected in securities prices.
- The strong form states that all information is fully reflected in securities prices.

Fama (1970) argues that at any given time in an efficient market the price of a security will match that security's intrinsic value, meaning that outperforming a benchmark index by trading securities is not possible.

Past crises in financial markets have motivated academics and practitioners to test the efficient market hypothesis stated by Fama (1970). Several researchers have documented numerous findings that contradict this hypothesis. One of them is Shefrin (2002), who introduced three main areas of controversy between the views of behavioural finance and the statements of traditional finance. Shefrin (2002) argues that investors use heuristics in their decision making, which leads them to have different biases and make irrational financial decisions, whereas traditional finance assumes that investors are always rational. Additionally, Shefrin (2002) believes that investors are influenced by how financial decisions are framed, which results in irrational decision making, while traditional finance in contrast assumes that investors make objective decisions based on risk and return. Furthermore, Shefrin (2002) claims that heuristic-driven biases and framing effects have an impact on market prices by driving them away from fundamental values. The opposite view is held by supporters of traditional finance theory, who claim that markets are efficient.

Pompian (2006) complements Shefrin's view by claiming that standard finance theory is designed to provide mathematically elegant explanations for financial questions that are often complicated by imprecision when posed in real life. The standard finance approach uses a set of assumptions that oversimplify reality. It requires that humans make perfectly rational economic decisions at all times. Pompian (2006) claims that standard finance is built on rules about how investors should behave, rather than on principles describing how they actually do behave. Behavioural finance attempts to identify and learn from human psychological phenomena and combine this with investors' behaviour in financial markets. Pompian (2006) argues that standard

finance grounds its assumptions in idealised financial behaviour and behavioural finance grounds its assumptions in observed financial behaviour.

Pompian (2006) suggests dividing behavioural finance into the micro and macro levels. Behavioural finance at the micro level explores the behaviours or biases of individual investors that distinguish them from the rational actors envisioned in classical economic theory. Behavioural finance at the macro level detects and describes anomalies in the efficient market hypothesis that behavioural models may explain. In recent decades the number of academic papers in behavioural finance has increased significantly and behavioural finance has assured its place in economics whether or not its views are universally accepted.

Many models in modern economics explaining how capital markets work, like the Capital Asset Pricing Model, have been built on the concept that human beings are rational agents who maximise their returns while minimising risk. These individuals assess the risk and return of all the possible investment options and choose an investment portfolio that matches their level of risk aversion. In real life situations individual investors behave differently from the investors in these models though. Barber and Odean (2013) and Barberis and Thaler (2003) summarise the most common mistakes and behavioural biases that affect individual investors at the micro level.

One of the most common mistakes that individual investors make in the stock market is to hold insufficiently diversified portfolios. Barberis and Thaler (2003) state that investors diversify their portfolio holdings much less than is recommended by normative models of portfolio choice, because investors exhibit a behavioural bias called “home bias”.

Barber and Odean (2013) state that not only do individual investors hold insufficiently diversified portfolios, they also trade actively and speculatively, and so transaction costs eat their returns. Barberis and Thaler (2003) have the same viewpoint and add that investors would do a lot better if they traded less. The underperformance of those investors is largely due to transaction costs. Barberis and Thaler (2003) state that the behavioural explanation for such excessive trading is overconfidence, as people believe that they have information strong enough to justify a trade, whereas in fact the information is too weak to warrant any action. This hypothesis immediately predicts that people who are more overconfident will trade more and, because of transaction costs, earn lower returns.

Another widely researched behavioural bias is called the “disposition effect”. This is behaviour by investors where they sell winning investments while holding on to their losing investments. Barberis and Thaler (2003) argue that the reason behind this kind of behaviour is that investors may have an irrational belief in mean-reversion.

Barber and Odean (2013) state that investors are influenced by where they live and work. They tend to hold stocks of companies close to where they live and invest heavily in the stock of their employer. Such behaviour leads to an investment portfolio that is far from the market portfolio prescribed by the CAPM, and arguably exposes investors to unnecessarily high levels of idiosyncratic risk.

Furthermore, Barber and Odean (2013) state that investors are influenced by the media. They tend to buy stocks, rather than sell them, when those stocks are in the news. This attention-based buying can lead investors to trade too speculatively and has the potential to influence the pricing of stocks. They argue that when people buy a stock, they do not tend to sift systematically through the thousands of listed shares

until they find a good buy. They typically buy a stock that has caught their attention and perhaps the best attention grabber is extreme past performance, whether good or bad.

Another mistake that investors make is to participate in initial public offerings when the market sentiment is optimistic. IPO events gain the attention of investors, but it is not considered to be a smart choice to participate in IPOs. Studies by several researchers show that stocks from IPOs tend to perform poorly compared to market benchmark indexes. The poor long-term performance of IPO stocks has also been documented by Arosio, Giudici, and Paleari (2001), who find a significant negative correlation between long-run relative performance and initial flipping, suggesting that some investors possess superior information on IPOs. Baker and Wurgler (2000) and Hirshleifer (2001) offer a behavioural explanation for poor performance subsequent to equity offerings suggesting that stock prices periodically diverge from fundamental values, and that IPO issuers take advantage of overpricing by selling stock to overly optimistic investors.

Previous studies show that the individual investor does not always behave rationally when it comes to making difficult decisions in the stock market. Motivated by the ongoing discussion between the traditional finance and behavioural finance standpoints, and by the findings of previous academic studies on investor's irrational behaviour, this thesis studies empirically how the education of investors affects their behaviour in the stock market. This thesis fills research gaps in the existing academic literature by offering new empirical evidence how comprehensive educational characteristics affect investors' portfolio diversification, trading activity and IPO participation choices in the stock market.

The current thesis takes the behavioural finance approach at a micro level and concentrates on the stock market behaviour of investors. The thesis presents the results of three published papers (Liivamägi, 2015, Liivamägi, 2016 and Liivamägi, Vaarmets and Talpsepp, 2018), of which the author of the thesis is the sole author or the first author. The thesis focuses on different aspects of behavioural finance and in particular the behaviour of investors in the stock market. The three papers study how educational characteristics affect investors' portfolio diversification, trading activity and IPO participation choices in the stock market.

The paper "Investor Education and Portfolio Diversification on the Stock Market" (Liivamägi, 2015) uses a unique comprehensive full business cycle dataset of the Estonian stock market and the national educational register to studies investors' portfolio diversification. Prior studies by Goetzmann and Kumar (2008) and Barber and Odean (2011) for investor portfolio diversification analysis have used subsamples and the general level of educational characteristics for the analysis because of the limited amount of available data. Paper I contributes to the existing literature on behavioural finance by using the unique dataset from the Nasdaq OMX Tallinn stock market, which covers transactions for the period from 2004 to 2012 together with exhaustive educational data from the Estonian Ministry of Education and Research. The combined dataset allows Paper I to analyse different individual investor types based on their gender, age, portfolio size, period of holding stocks, number of transactions and level of education, and their distribution by type of education, high school grades and high school ranks.

The academic contribution of the paper "Investor Education and Portfolio Diversification on the Stock Market" (Liivamägi, 2015) is the first empirical

documentation of the detailed educational characteristics which affect the diversification of investors' stock market portfolios. Paper I extends the findings of previous studies and offers empirical evidence that investors with top results in national exams in mathematics, native language and geography hold more diversified portfolios. The paper concludes that investors with higher academic education and a university degree in natural sciences, mathematics or statistics hold more diversified portfolios. Paper I states that the opposite is true for investors with no academic degree and low performance in mathematics and native language exams as they hold less diversified portfolios. In addition, Paper I concludes that investors with more diversified portfolios achieve higher risk-adjusted returns in the stock market.

The paper has been published in the journal *Research in Economics and Business: Central and Eastern Europe*, vol. 7, no. 2. The preliminary results of the paper were presented at the 7th international conference *Economic Challenges in Enlarged Europe* in Tallinn, Estonia 2015 and the *World Finance & Banking Symposium* in the United Arab Emirates, Dubai 2016, and the empirical results have been discussed at seminars at Tallinn University of Technology.

The paper "Investor Education and Trading Activity on the Stock Market" (Liivamägi, 2016) analyses how investors' educational characteristics affect their trading activity on the stock market. Prior studies by Anderson (2007), Goetzmann and Kumar (2008) and Grable (1998) state that education is a key factor explaining investors' behaviour in the stock market. The limited availability of data meant prior studies were not able to study what kind of effects education has on the trading activity of investors. This study uses the same unique dataset as in Paper I to address the research gap in the literature. The main contribution of the paper to the existing academic literature is the empirical documentation of the comprehensive educational characteristics which influence the trading activity of investors in the stock market.

Paper II builds on the documentation of previous studies in behavioural finance and offers new evidence that investors with an academic degree and top results in national exams are more likely to trade actively in the stock market. In addition, the study concludes that investors with an academic degree in natural sciences trade more actively than do investors without such a degree. Paper II argues that the opposite is true for investors with no academic degree and for investors with poor performance in geography exam results as they execute a lower number of trades. The paper concludes that trading experience is a key contributing factor to better performance.

The paper has been published in the journal *Baltic Journal of Economics*, vol. 16, no. 2. The preliminary results of the paper were presented at the 8th international conference *Economic Challenges in Enlarged Europe* in Tallinn, Estonia 2016, and the empirical results have been discussed at seminars at Tallinn University of Technology.

The paper "Investor Education and IPO Participation" (Liivamägi, Vaarmets and Talpsepp 2018) assesses how the educational characteristics of investors affect their participation in initial public offerings in the stock market. The main contribution of the paper to the existing academic literature is the detailed documentation of the extensive educational characteristics which influence investors' IPO participation choices. The paper adds an extended insight to the literature on behavioural finance by providing empirical evidence that investors with better high school exam results in mathematics and high school leavers without an academic degree are less likely to participate in an IPO. The paper claims that the opposite is true for investors who have higher

education, a bachelor's degree or a degree in the social sciences, economics or public administration, all of whom are more likely to participate in an IPO. The study confirms the results of Keloharju (1993) and Schultz (2003), who suggest that the long-term performance of IPO stocks underperforms benchmark index returns.

The paper has been accepted for publication in the journal *Emerging Markets Finance and Trade*. The results of the paper were presented at seminars at Tallinn University of Technology.

Paper I, Paper II and Paper III contribute to the literature on behavioural finance by shedding new light on the process by which investors make financial decisions and on their individual stock market behaviour in relation to their comprehensive educational characteristics. As the topics covered in the thesis are just one small step forward towards understanding the behaviour of individual investors and the decision making process in the stock market, the author of the thesis will conduct further research into the risk-taking behaviour of investors in the stock market.

The thesis is organised as follows: Section 1 gives an overview of the literature. Section 2 presents the data and methodology used in Paper I, Paper II and Paper III. The final comments section combines them and draws parallels on investors' education and their stock market behaviour and presents the key results of Paper I, Paper II and Paper III.

1. LITERATURE REVIEW

The theoretical and empirical literature on behavioural finance has thoroughly investigated the behaviour of individual investors in the stock market. The debate in behavioural finance on a macro level is still ongoing and there is no clear answer as to whether investors are rational and the efficient market hypothesis presented by Fama (1970) applies, or whether they tend to be affected by emotions and psychological biases. Nevertheless, studies at the micro level indicate that individual investors do not always make rational investment decisions in the stock market and at least sometimes are biased in their financial decisions. The following sections present an overview of previous academic studies and the findings about how investors behave in the stock market.

1.1 Investor portfolio diversification

Several studies have focused on a research question about investor portfolio diversification in the stock market. Fama (1970) states in his efficient market hypothesis that investors should be rational and hold a diversified portfolio to minimise the impact of unnecessary volatility and risk on their portfolios. In reality investors do not always act rationally and Goetzmann and Kumar (2008) and Barber and Odean (2011) find that investors hold under-diversified portfolios and take unnecessary risks and therefore experience lower stock market performance. Similar findings are presented by Mitchell and Utkus (2003), who offer evidence that some investors overinvest in the stock of their employer's company and so are exposed to idiosyncratic risk. They claim that many investors hold their pension account investments in their employer's stock and therefore fail to diversify the idiosyncratic risk. Poterba (2003) adds to this finding that almost half of the assets of defined contribution plans managed by corporations are invested in company stock. In contradiction of Fama's (1970) efficient market hypothesis and his assumption that investors behave rationally the reality seems to be the opposite.

Various studies find that many investors hold excessively few stocks in their portfolios and consequently face additional economic costs. Goetzmann and Kumar (2008) analyse the under-diversification of individual US investors and find that investors hold portfolios that are highly volatile and consist of stocks that are more highly correlated than they would be if they were chosen randomly. They find that individual US investors hold under-diversified portfolios, where the level of under-diversification is greater among younger, lower-income, less-educated, and less-sophisticated investors. Barber and Odean (2011) supplement these findings by noting that, on average, individual US investors in the LDB dataset hold only four stocks in their portfolio. In addition, French and Poterba (1991) provide empirical evidence that investors prefer local and familiar stocks and avoid investing in foreign stocks, even though these provide more diversification benefits and lower additional economic costs and portfolio volatility. Previous studies show that when it comes to investing, people tend to make irrational investment decisions and are affected by behavioural biases, which contradicts Fama (1970) and the efficient market hypothesis.

Studies by Anderson (2007) and Goetzmann and Kumar (2008) conclude that some groups of investors tend to act irrationally, particularly younger, lower-income, less-educated and less-sophisticated investors, who hold too few stocks in their portfolios and overinvest in their employer's company stock, local stocks and domestic companies, which exposes their portfolio to greater risks.

Previous studies have used subsamples and analysed the high-level educational impact on investors' portfolio diversification, but none of them studied how comprehensive educational characteristics such as the type or level of education and high school grades or final exams affect investors' portfolio diversification choices in the stock market. Paper I uses a unique dataset from the Nasdaq OMX Tallinn and the Estonian Ministry of Education and Research and so is able to fill the research gap in the existing academic literature.

1.2 Investor trading activity

Fama (1970) in his efficient market hypothesis, together with other academics, assumes that investors analyse their investments in detail and behave rationally as they are putting their own money on the table, but in reality, the opposite seems to be the case. Griffin and Tversky (1992) find that when outcome predictability is very low, as can be observed in the stock market, even experts oversimplify their investment decisions, which leads them to make poor decisions. Shefrin (2002) reveals the reasons behind faulty and irrational investment choices by stating that investors tend to oversimplify situations. Shefrin (2002) claims that heuristically driven biases and framing effects have an impact on market prices by driving them away from fundamental values.

Daniel, Hirshleifer, and Subrahmanyam (1998) and Gervais and Odean (2001) state that investors do learn from previous mistakes and that those mistakes are not systematic. Although several empirical studies have been conducted, the results for individual learning are mixed. Knetsch and Sinden (1984) and Camerer and Hogarth (1999) argue that learning can take a long time and may not be effective in eliminating behavioural biases. Nicolosi, Peng, and Zhu (2009) argue that not only does the laboratory setup fail to capture investor behaviour accurately when significant wealth is at stake, but the subjects also deal with relatively simple signals and tasks, leading to more restricted learning. They state that learning in a trading environment can be more challenging.

Even so, studies show that real life trading experience plays a significant role in eliminating such judgment errors as the endowment effect (List, 2003) and the disposition effect (Dhar and Zhu, 2006). In addition, Roth and Erev (1998) and Feng and Seasholes (2005) show evidence that investor sophistication and trading experience help to reduce certain behavioural biases in financial markets and that individuals' behaviour improves over time. Determining whether education affects investor trading experience in the form of trading activity would be one important step forward in understanding the financial decision-making processes of investors in the stock market and would make a significant contribution to the existing academic literature.

In contrast, several authors have initiated a discussion as to whether active trading is beneficial for the performance of investors. Feng and Seasholes (2005) and Nicolosi et al. (2009) use the number of transactions as a proxy for investor experience and conclude that trading experience helps people to achieve better performance in the

stock market. Coming from the opposite side, Grinblatt and Keloharju (2009) and Barber and Odean (2001) use the number of transactions as a proxy for investor overconfidence and find that too much trading has a negative effect on investors' wealth. So the debate about whether active trading is beneficial for the investor is still ongoing.

Previous research in household finance suggests that education has a significant impact on investors' financial decisions, including their stock market participation choices (Guiso, Haliassos, and Jappelli, 2003; Grinblatt, Keloharju, and Linnainmaa, 2011)), risk taking behaviour (Haliassos and Bertaut, 1995) and performance (Gottesman and Morey, 2006). Hence, it could be presumed that education also has an impact on the trading activity of investors. Paper II contributes to the existing academic literature by providing empirical evidence for how comprehensive educational characteristics affect the trading activity of investors and whether investors learn from their trading experience and demonstrate better performance in the stock market. Paper II compares the risk-adjusted returns of investors in the stock market as was done previously by Nicolosi et al. (2009) to test the learning effect. Paper II uses the unique dataset from the Nasdaq OMX Tallinn and Estonian Ministry of Education and Research to answer the research question and fill the research gap in the existing academic literature.

1.3 Investor IPO participation

Earlier studies suggest that the decision of an investor to participate in an IPO is influenced by that individual's past experience. Chiang et al. (2011) examine the relationship between an investor's past returns from previous IPO auctions and their inclination to participate in future IPO auctions. They find that individual investors tend to bid in further IPOs if they received high returns in the past and tend to stop bidding if their past returns were poor. This viewpoint is shared by Kaustia and Knüpfer (2008), who claim that investors learn from their past experience of IPO participation. They provide evidence suggesting that individual investors are more likely to participate in IPOs after they have had good returns from earlier IPOs. This shows that the decision about the IPO investment is influenced by the investor's prior experience.

IPO events gain the attention of investors, but participating in IPOs is not always considered to be a wise choice. Studies show that stocks from IPOs tend to perform poorly compared to benchmark market indexes. The poor long-term performance of IPO stocks has also been documented by Arosio, Giudici, and Paleari (2001), who find a significant negative correlation between long-run relative performance and initial flipping, suggesting that some investors possess superior information on IPOs. Baker and Wurgler (2000), Ritter (1991) and Hirshleifer (2001) offer a behavioural explanation for poor performance subsequent to equity offerings. They suggest that stock prices periodically diverge from fundamental values, and that IPO issuers take advantage of overpricing by selling stock to overly optimistic investors. They argue that the equity share sometimes predicts significantly negative market returns, suggesting inefficiency, and that firms time the market component of their returns when issuing securities. Ljungqvist, Nanda and Singh (2006) add to this by claiming that under-pricing and long-run underperformance emerge as underwriters attempt to maximise profits from the sale of equity at the expense of the optimistic investors. Schultz (2003) concludes that

underperformance is very likely to be observed ex-post in an efficient market. The assumption is that more firms issue equity at higher stock prices even though they cannot predict future returns.

Despite the poor long-term performance of IPOs, investors are still optimistic about IPO performance, which might be because of the relatively good short-term returns from IPOs. Derrien (2005) finds that IPOs can be overpriced and still exhibit a positive initial return. He suggests that large demand from individual investors leads to high IPO prices, large initial returns and poor long-run performance. A similar conclusion is drawn by Arosio, Giudici, and Paleari (2001), who find that the short-term performance of IPOs exceeds benchmark market indexes, but the long-term performance is worse than that of benchmark market indexes.

Prior research suggests that sentiment plays a crucial role in how investors behave in IPOs. Cornelli, Goldreich and Ljungqvist (2006) state that when small investors are excessively optimistic, they are willing to pay a price above the fundamental value, resulting in a high aftermarket price. Derrien (2005) concludes that demand from individual investors is positively related to market conditions. Brown and Cliff (2004) find that sentiment levels and changes are strongly correlated with contemporaneous market returns, but sentiment has little predictive power for near-term future stock returns. Market timing is important for IPOs and this is also known by insiders, who accordingly launch their IPOs when market conditions are favourable. Brau and Fawcett (2006) find in their study that CFOs base IPO timing on overall market conditions and are well informed about expected under-pricing. As market participants are aware of IPO under-pricing, Ritter and Welch (2002) argue that IPO under-pricing and long-run performance may be explained by behavioural issues.

Firm-specific characteristics play an important role in IPO success as well. Bruton et. al (2010) examine the effects on performance of concentration of ownership in firms that have recently had an IPO. They find that concentrated ownership improves IPO performance and show that venture capitalists and business angels impact performance differently. Previous studies show that the reputation of the underwriters (Carter and Manaster, 1990), association with prominent venture capital firms (Gulati and Higgins, 2003), and the financial characteristics of companies (Ritter and Welch, 2002) matter for IPO success.

Guiso, Haliassos, and Jappelli (2003) and Grinblatt, Keloharju, and Linnainmaa (2011) find that education is a key characteristic for explaining the participation of investors in the stock market. However, there is no answer to the question of how detailed educational characteristics can affect the participation of investors in initial public offerings. Paper III addresses the research question of how comprehensive educational characteristics influence investor choices about participating in IPOs in the stock market by using a unique dataset from the Estonian stock exchange and combining it with a national education dataset that contains educational information on those investors.

2. DATA AND METHODOLOGY

Paper I, Paper II and Paper III use a unique and comprehensive dataset from the only stock exchange in Estonia, the Nasdaq OMX Tallinn stock exchange. The data covers transactions of a total of 23 listed companies that were traded on the Estonian stock exchange, and the data covers the period of nine years from 01.01.2004 to 31.12.2012. The Nasdaq OMX Tallinn had a market capitalisation of about 2.2 billion euros as at 30.06.2017.

Alongside the data from the Nasdaq OMX Tallinn the papers use a unique dataset from Estonian Ministry of Education and Research. This dataset contains all the high school grades and results of high school final exams starting from their introduction in 1997 until 2012. The final dataset combines those two unique datasets, allowing different individual investor types to be analysed by their gender, age, portfolio size, period of holding stocks, number of transactions, level of education (high school, bachelor, master or doctor), type of education (physics, psychology, mathematics, economics, finance, medicine, law, information technology, public administration or chemistry), high school grades, and high school ranks.

Paper I finds that investors hold 1.86 stocks in their portfolio on average, which is a relatively small number next to the 23 different stocks available to them. The total number of different investors who made at least one purchase trade during the sample period is 33,843, of whom 25,426 are individual investors. Although the stock market data were obtained for the whole population, it was possible to tie educational data only to those investors whose data are in the educational register, which reduced the sample to about one third of all the investors. As there were no national state exams or educational register before 1997, the sample consists of quite young investors, with an average age of about 29 years in 2012.

Paper I uses risk-adjusted performance (RAP) and Sharpe ratio to measure performance. The final dataset includes daily transaction data, transaction prices and specific stocks for all investors. As the prices at which investors purchased stock before January 2004 have not been obtained, the positions opened before that are not used for the calculations. Prices were adjusted for stock splits and dividends.

Paper I measures the diversification of investors by the average number of stocks they held in their portfolios and uses control variables, such as gender, age, wealth, experience and trading characteristics. Paper I uses aggregate data to get an indicator for the average return during the period observed for investors. As investors can also trade foreign stocks and increase or reduce the amount invested, which has an effect on performance, the portfolio return is calculated as an annual money-weighted return. Each transaction has been adjusted for transaction costs of five euros + 0.1% * (transaction amount).

Markowitz (1991) and Modigliani and Modigliani (1997) state that to get a fair measure of the performance of investors, the risk that is associated with the particular investment should be taken into account. Therefore each individual's risk-adjusted returns are calculated, because some investors might intentionally take higher risk in order to achieve higher returns. Paper I measures risk-adjusted performance using the risk-adjusted return as defined by Modigliani and Modigliani (1997).

Paper II measures investors' trading activity as the total number of transactions executed by the investor and uses control variables such as gender, age, portfolio size, portfolio diversification and the average stock holding period following the documentation of Feng and Seasholes (2005) and Grinblatt and Keloharju (2009). It analyses and interprets the data using probability models, specifically an ordered logit regression model, to identify the effects of educational characteristics on investor trading activity.

Paper II analyses different exam results in a single model and a multivariable model to identify the effects on an isolated regression and on one together with control variables. The study divides the exam results into quartiles in order to analyse how the top and bottom exam results affect the trading activity of investors. The traders in the sample are relatively young and most of the investors are from Generation Y, because students take the national exams around the age of 18 and the dataset obtained from the Estonian Ministry of Education and Research starts from the year 1997.

Paper III uses the same dataset as Paper I and Paper II. The average number of individual investors participating in IPOs during the sample period was 4641, which is 18.3% of total number of individual investors. The largest IPO had 17,114 participants and the least popular had 1358 participants who were individual investors.

The new IPOs during 2004-2012 accounted for 22.1% of the total market capitalisation of the Tallinn stock exchange. The largest company that had an IPO during the period had market capitalisation of 183.1 million euros, which was 8.1% of the total market capitalisation at the time. The smallest IPO provided 0.6% of the total market capitalisation. In all, 87.5% of the IPOs were made during the years of economic growth in the years 2005-2007 when the economy was growing by more than 9% a year. Similar hot periods in the IPO market have been documented in other European and US stock markets as well (Arosio, Giudici, and Paleari, 2001; Ibbotson and Jaffe, 1975; Lowry and Schwert, 2002; and Ibbotson, Sindelar, and Ritter, 1994).

Paper III used probit regression models for the data analysis. The choice of control variables such as the investor's gender, age, portfolio size as a proxy for wealth, experience and trading characteristics was based on similar work by Kaustia and Knüpfer (2008), Grinblatt, Keloharju, and Linnainmaa (2011), Barber and Odean (2000), Goetzmann and Kumar (2008), Anderson (2007), and Nguyen and Schuessler (2012), who have used similar control variables for analysing IPO and stock market participation and the financial decision-making choices of investors in the stock market.

3. FINAL COMMENTS AND DISCUSSION OF KEY RESULTS

The debate about whether investors make rational investment decisions in the stock market and maximise their utility is still ongoing between supporters of the traditional view of finance such as Fama (1970) and those of behavioural finance such as Shefrin (2002). This thesis contributes to the academic literature and provides empirical evidence on how education affects the participation of investors in IPOs, the diversification of their portfolios, and their trading activity in the stock market.

All three papers contribute to the academic literature on behavioural finance in their particular fields. Paper I contributes to the academic literature by analysing how educational characteristics affect the portfolio diversification of investors in the stock market. Paper I combines a unique dataset from the Tallinn stock exchange with an official educational dataset and provides empirical evidence that investors with higher academic education and top results in national high school exams in mathematics, native language and geography hold more diversified portfolios.

In addition, the paper finds that investors holding a degree in natural sciences, mathematics or statistics hold more diversified portfolios than investors with no such educational characteristics. Furthermore, the study concludes that investors with poor results in their mathematics and native language exams and investors with no academic university degree hold less diversified portfolios. Paper I analyses the risk-adjusted performance of investors and concludes that higher portfolio diversification is a significant factor that contributes to higher returns in the stock market. This means that rational investors should hold diversified portfolios in order to minimise portfolio volatility and risks and to achieve higher risk-adjusted returns.

Paper II analyses how the educational characteristics of investors affect their trading activity in the stock market. Paper II provides empirical evidence that investors with the top results in national exams or those who hold an academic degree trade stocks more actively. The paper states that the opposite is true for investors with no academic degree, as they trade stocks less actively. Paper II analyses the risk-adjusted performance of investors and concludes that trading experience in the form of trading activity is a significant contributing factor to higher returns on the stock market. As a result, more experienced investors achieve better performance in the stock market.

Paper III analyses how the educational characteristics of investors affect their participation in initial public offerings in the stock market. The main contribution of the paper to the existing academic literature is that investors with better high school exam results in mathematics and high school leavers without an academic degree are less likely to participate in an IPO. The study finds the opposite to be true for investors who have higher education, a bachelor's degree or a degree in social sciences, economics or public administration, who are all more likely to participate in an IPO. The study suggests that the long-term performance of IPO stocks underperforms benchmark index returns.

The papers in the thesis do not close a research topic in field of investor behaviour, but rather map out the road for further research. There are many more topics and papers to follow in field of behavioural finance and this is just the beginning of a very long journey.

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ABSTRACT

Education and Investor Behaviour

The current thesis contributes to and extends the academic literature in the field of behavioural finance and in particular it focuses on the education, portfolio diversification, trading activity and IPO participation of investors. The current thesis presents the results of Paper I, Paper II and Paper III.

Many researchers with a traditional view of finance, including Fama (1970), claim that investors' behaviour in the stock market should be rational, meaning that investors should be free of any behavioural biases that influence their investment decisions. The current thesis sheds light on the various aspects of investor behaviour in the stock market and provides empirical evidence that individual investors are indeed influenced by different behavioural biases that have an effect on their investment behaviour and stock market performance.

The main contribution of the thesis is the first empirical documentation of the comprehensive educational characteristics that influence the stock market trading activity, portfolio diversification and IPO participation choices of investors. The thesis uses a unique full business cycle dataset from the Tallinn stock exchange and from the Estonian Ministry of Education and Research. This unique dataset helps to answer questions that have been raised by other behavioural finance researchers but have remained unanswered due to the limited availability of the data.

The first publication "Investor Education and Portfolio Diversification on the Stock Market" analyses how educational characteristics affect the portfolio diversification of investors in the stock market and provides evidence that greater portfolio diversification contributes to higher returns from the stock market.

The second publication "Investor Education and Trading Activity on the Stock Market" analyses how investors' educational characteristics affect their trading activity in the stock market and concludes that trading experience in the form of trading activity has a positive impact on returns from the stock market.

The third publication "Investor Education and IPO Participation" analyses how education affects the participation of investors in IPOs in the stock market and provides evidence that investors with better high school exam results in mathematics and high school leavers without an academic degree are less likely to participate in an IPO. The opposite is true for investors who have higher education, a bachelor's degree or a degree in the social sciences, economics or public administration, who are all more likely to participate in an IPO.

All three publications contribute to the literature on behavioural finance by providing empirical evidence that education is a key factor determining the behaviour and investment decisions of investors in the stock market. Investors with a higher level of education and a particular type of education tend to make more rational investment decisions such as holding a more diversified portfolio, and this contributes to higher risk-adjusted performance in the stock market.

KOKKUVÕTE

Haridus ja investori käitumine

Käesolev doktoritöö „Haridus ja investori käitumine“ keskendub investorite hariduse, esmasel aktsiate avalikul pakkumisel osalemise, portfelli hajutamise ja tehinguaktiivsuse analüüsimisele aktsiaturul ning lähtub käitumusliku rahanduse mikrotasandi vaatenurgast. Käesolev doktoritöö annab ülevaate kasutatud metodoloogiast, andmetest ja teoreetilisest taustast ning võtab kokku teadustöö tulemused artiklitest: Liivamägi (2015), Liivamägi (2016) ja Liivamägi, Vaarmets ja Talpsepp (2018).

Mitmed käitumusliku rahanduse autorid, muuhulgas Fama (1970) väidavad, et investorite käitumine aktsiaturul on ratsionaalne ning investor on vaba käitumuslikest kõrvalekalletest, mis mõjutavad tema investeerimisotsuseid. Paraku mitte kõik akadeemikud ja praktikud ei nõustu selle ettepanekuga. Üheks nendest on Shefrin (2002), kes väidab, et investorid kasutavad investeerimisotsuste tegemisel erinevaid heuristikuid, mis põhjustavad investorite irratsionaalset käitumist finantsturgudel. Antud doktoritöö keskendub erinevatele investori käitumist mõjutavatele aspektidele aktsiaturul ja esitab empiirilisi tõendeid, et erainvestorid on mõjutatud erinevatest käitumuslikest kõrvalekalletest.

Antud doktoritöö annab arvestatava panuse teadusesse, kuna see on esimene laiapõhjaline empiiriline uuring haridusnäitajate kohta, mis mõjutavad erainvestori esmasel aktsiate avalikul pakkumisel osalemist, portfelli hajutamist ja tehinguaktiivsust. Selle uuringu koostamiseks kasutatakse unikaalseid ja laiapõhjalisi Tallinna börsi, Haridus- ja Teadusministeeriumi, Maksu- ja Tolliameti ning 2011. aastal teostatud rahvaloenduse andmeid. Nende unikaalsete andmete ühendamine võimaldab leida vastuse siiani mitmeid autoreid kummitanud, kuid andmete puudulikkuse tõttu vastuseta jäänud üürimisküsimustele.

Doktoritöö esimene publikatsioon „Investori haridus ja portfelli hajutamine aktsiaturul” kasutab Tallinna börsi ja Haridus- ja Teadusministeeriumi unikaalset ühendatud andmekogumit ja uurib millist mõju omavad investorite erinevad hariduslikud karakteristikud portfelli hajutamisele. Eelnevalt on uurinud investorite hariduse mõju portfelli hajutamisele Goetzmann ja Kumar (2008) ning Barber ja Odean (2011) poolt, kuid nad on andmete puudulikkuse tõttu kasutanud analüüsimisel osavalimeid ja üldist hariduse taset, mille tõttu ei ole järeldused olnud täielikud.

Artikkel I kasutab unikaalset andmestikku, mis on saadud Nasdaq OMX Tallinn ja Haridus- ja Teadusministeeriumi andmete ühendamisel. Tegemist on täieliku majandustsüklite andmestikuga perioodil 2004 – 2012, mis võimaldab analüüsida erinevaid investorite tüüpe demograafiliste näitajate, portfelli suuruse, aktsiate hoidmisperioodi, portfelli hajutamise, tehingute arvu, haridustaseme, haridustüübi, riigieksami tulemuste ja hinnete osas.

Antud unikaalne andmestik võimaldab uurida investorite hariduse ja portfelli hajutamise vahelist seost ning annab seeläbi uudse ja olulise panuse käitumusliku rahanduse kirjandusse. Uuringu tulemustest selgub, et investorite haridus mängib olulist rolli nende investeerimiskäitumise ja –otsuste tegemisel aktsiaturgudel. Uuringust selgub, et investorid, kellel on head tulemused riigieksamitel matemaatikas, emakeeles või geograafias hoiavad oma portfellis rohkem aktsiaid kui investorid kes on

vähem edukad nendes eksamites. Lisaks selgub uuringust, et investorid, kellel on akadeemiline kõrgharidus või ülikooli kraad reaalteadustes, matemaatikas või statistikas omavad oma portfellis rohkem aktsiaid kui investorid kellel puuduvad need hariduslikud karakteristikud.

Analüüsides investorite riskiga korrigeeritud tulu jaotust selgub artiklist, et majanduslik kahju portfelli vähesest hajutamisest aktsiate vahel on oluline suurele osale investoritest. Need investorid, kes omavad portfellis vähem aktsiaid kogevad suuremat volatiilsust ja võtavad rohkem riski finantsturgudel, mille eest nad ei saa kompenseeritud tootluses. Ainult edukam kvartiil investoritest saavutas positiivse Sharpe'i suhtarvu, mis tähendab, et ülejäänud investoritel oleks perioodil 2004 – 2012 olnud ratsionaalsem paigutada oma varad riskivabasse aktivasse ning mitte investeerida individuaalsetesse aktsiatesse.

Doktoritöö teine publikatsioon „Investori haridus ja tehinguaktiivsus aktsiaturul" analüüsib Tallinna börsi investorite hariduse mõju aktsiatehingute aktiivsusele. Anderson (2007), Goetzmann ja Kumar (2008) ja Grable (1998) jõuavad oma uuringutes järeldusele, et haridus on oluline tegur, mis selgitab investorite käitumist finantsturgudel. Siiski ei ole eelnevad uuringud andmete puudulikkuse tõttu suutnud tuvastada, et millist mõju omab haridus investorite tehinguaktiivsusele. Artikkel II kasutab antud uurimisküsimuse analüüsimiseks unikaalset andmestikku, mis on saadud Tallinna börsi ja Haridus- ja Teadusministeeriumi andmete ühendamisel.

Artikkel II täiendab käitumusliku rahanduse kirjandust järeldades uuringus, et investorid, kes omavad akadeemilist ülikooli haridust ja on saavutanud riigieksamitel häid tulemusi on aktsiaturgudel tehingute tegemisel aktiivsemad. Lisaks selgub uuringust, et reaalteaduste kraadi omavad investorid teevad võrreldes seda kraadi mitte omavate investoritega rohkem tehinguid. Vastupidist saab väita investorite kohta, kellel ei ole ülikooli lõputunnistust või kellel on kehvad riigieksamite tulemused geograafias, kuna nende tehinguaktiivsus aktsiaturgudel on madal. Artikkel toob välja, et kõrgharidusega ja reaalteaduste kraadi omavate investorite suurem tehinguaktiivsus võib olla tingitud nende kõrgemast intellektuaalsest võimekusest, mida need investorid arendavad edasi ülikooli õpingute käigus.

Lisaks hariduslikele karakteristikutele analüüsib antud artikkel investorite demograafilisi näitajaid, aktsiate arvu portfellis, keskmist portfelli suurust ja keskmist aktsiate hoidmise perioodi ning nende mõju tehinguaktiivsusele aktsiaturgudel. Demograafilistest näitajatest on statistiliselt oluline ainult sugu. Artikkel järeldab, et meessoost investorid teostavad rohkem tehinguid kui naissoost investorid. Need tulemused on kooskõlas Barber ja Odean (2001) uuringu tulemustega, mis väidab, et mehed teevad naistest aktsiaturgudel 45% rohkem tehinguid.

Artikkel II jõuab järeldusele, et suurema investeerimisportfelliga investorid on aktsiaturul aktiivsemad ja teevad rohkem tehinguid. Sarnase tulemuseni on jõudnud ka Graham et al. (2009), kes leidsid, et jõukamad investorid peavad ennast teistest kompetentsemateks ja seetõttu kauplevad aktsiaturul rohkem. Lisaks selgus, et rohkem tehinguid tegevad investorid hajutavad oma portfelli rohkem, aga hoiavad aktsiaid portfellis lühemat aega. Antud tulemused on sarnased Grinblatt and Keloharju (2009) järeldustega.

Artikkel II uurib lisaks hariduse mõjule, kuidas investorite poolt tehtud tehingute arv mõjutab portfelli riskiga korrigeeritud tootlust. Artikkel jõuab järeldusele, et tehingute arv, mida kasutatakse investori kogemuse hindamiseks, omab terve majandustsükli

vältel positiivset mõju portfelli riskiga korrigeeritud tootlusele. Esmasel hinnangul tundub see tulemus olevat vastuolus Barber ja Odean (2000) ning Barber ja Odean (2001) tulemustega, mis väidavad, et liiga suur tehingute arv vähendab investorite tootlust aktsiaturul. Detailsem analüüs näitab siiski, et vastuolu ei eksisteeri. Artikkel II jagab investorid kümnesse kategooriasse lähtudes nende tehinguaktiivsusest ja leiab, et kuni 100 tehinguni aitab suurem tehingute arv saavutada paremat tootlust aktsiaturul, aga üle 100 tehingu tegevad investorid kogevad riskiga korrigeeritud tootluse langust tänu suurenenud tehingukuludele. See tulemus on kooskõlas Barber ja Odean (2000) väitega, et liiga palju tehinguid mõjutavad negatiivselt investorite tootlust. Samuti on see tulemus kooskõlas ka Nicolosi et al. (2009) uuringu tulemustega, et tehingute tegemisest saadav kogemus kuni mingi ulatuseni aitab saavutada paremat tootlust aktsiaturgudel.

Doktoritöö kolmas publikatsioon „Investori haridus ja esmasel aktsiate avalikul pakkumisel osalemine" analüüsib investorite hariduse mõju esmasel aktsiate avalikul pakkumisel osalemise osas. Liivamägi, Vaarmets ja Talpsepp (2018) jõuavad järeldusele, et kõrgema matemaatika riigieksamite tulemustega investorid ja investorid, kellel ei ole kõrgharidust osalevad väiksema tõenäosusega esmastel avalikel aktsiate pakkumisel. Vastupidist saab väita investorite kohta, kellel on kõrgharidus, bakalaureuse kraad või kraad sotsiaalteadustes, majanduses või avalikus halduses, kuna nemad osalevad suurema tõenäosusega esmastel avalikel aktsiate pakkumistel.

Kõik kolm teaduspublikatsiooni panustavad käitumusliku rahanduse erialasesse kirjandusse läbi empiiriliste uuringute tulemuste ja unikaalsete leidude. Kokkuvõttes saab väita, et investorid, kes on kõrgemalt haritud teevad aktsiaturgudel ratsionaalsemaid investeerimisotsuseid, hajutavad enda portfelli rohkem ja seeläbi teenivad kõrgemat riskiga korrigeeritud tootlust.

Appendix

PAPER I

INVESTOR EDUCATION AND PORTFOLIO DIVERSIFICATION ON THE STOCK MAKRET

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Investor Education and Portfolio Diversification on the Stock Market

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Abstract

This study analyses how educational characteristics affect investor portfolio diversification on the stock market. I use a unique dataset from the Tallinn stock exchange, covering stock market transactions of a full business cycle from 2004 to 2012, with an official educational dataset. Having controlled for gender, age, wealth and investor trading behaviour, I provide empirical evidence that investors with higher academic education and top results in national high school exams in mathematics, mother tongue and geography hold more diversified portfolios. In addition, investors with a degree in the natural sciences, mathematics or statistics hold more diversified portfolios compared to investors with no such educational characteristics. Furthermore, investors with poor results in their mathematics and mother tongue exams and investors with no academic university degree hold less diversified portfolios. Analysing investor risk-adjusted performance reveals that higher portfolio diversification is a significant factor contributing to higher returns on the stock market.

JEL classification: G11, I22
Keywords: portfolio diversification, education, stock market, performance, investor

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1. Introduction

Portfolio diversification between different assets is a portfolio management strategy to reduce the unsystematic risk of an investment portfolio. Trading decisions by investors in financial markets are assumed to be rational; nevertheless, under-diversification with unnecessary risk taking and lower stock market performance among some investors has been documented by Goetzmann and Kumar (2008) and Barber and Odean (2011). On the other hand, there are groups of investors who hold more diversified portfolios and with that avoid unnecessary risk-taking. What makes some investors diversify more between stocks than others? Is it age, experience, wealth, higher education, specific type of education or something else? The puzzle over how detailed educational characteristics influence investor portfolio diversification with stock market performance during a full business cycle has haunted many researchers, and has remained as yet unanswered due to the limitations of available data. I use a unique full business cycle dataset from the Nasdaq OMX Tallinn stock market, which covers transactions for the period from 2004 to 2012 with educational data from the Estonian Ministry of Education and Research, to answer this question.

My aim is to study how educational characteristics such as level and type of education and high school final exam results contribute to diversification among investors. An ordered logit regression with marginal analysis is used to identify the educational characteristics influencing investor diversification during the business cycle as defined by Aguiar and Gopinath (2007). Control variables, such as gender, age, wealth, experience and trading characteristics are derived based on documentation from Anderson (2007) and Goetzmann and Kumar (2008).

It has been documented that investors should hold a diversified portfolio of assets to minimize the impact of idiosyncratic risk on their monetary investments. Investors who overinvest in their employer company stock are exposed to idiosyncratic risk and there are many studies claiming that far too many investors fail to diversify this risk. Mitchell and Utkus (2003) estimate that more than 11 million survey respondents held over 20 per cent of their 401(k) account in their employer's stock and of that group five million participants had 60 per cent or more in company stock. Goetzmann and Kumar (2008) add to this by showing that individual US investors hold under-diversified portfolios, where the level of under-diversification is greater among younger, low-income, less-educated and less-sophisticated investors. The level of under-diversification is also correlated with investment choices that are consistent with over-confidence, trend-following behaviour and local bias.

Under-diversification by individual investors increases the portfolio volatility relative to the market portfolio, and therefore, decreases investor performance on the stock market as documented by Goetzmann and Kumar (2008). They claim that investors with higher levels of education hold more diversified portfolios, which contributes to better performance on the stock market. Several authors such as Nguyen and Schuessler (2012) and Kumar (2009) add to this by confirming that a higher level of education increases investor stock market performance. Hence, I set a hypothesis that investors with higher national high school exam results and higher educational levels, hold more diversified portfolios, and therefore, achieve better risk-adjusted performance on the stock market compared to investors with no such educational characteristics. Furthermore, I set a hypothesis that investors with no academic university degree and poor results in national high school exams hold less diversified portfolios and experience lower performance on the stock market compared to investors with no such educational characteristics.

Prior studies of investor portfolio diversification have used subsample analysis due to the limitation of available data. I use a complete business cycle dataset to avoid any biases arising from choosing only subsamples, which might lead to incomplete results. Hoffmann, Post, and Pennings (2013) note that individual investor perceptions have changed and have driven trading and risk taking behaviour during the 2008–2009 financial crisis. Investor perceptions have fluctuated during the crisis, with risk tolerance and risk perceptions being less volatile than return expectations. Kim and Nofsinger (2007) add to this by studying individual Japanese investors by contrasting their behaviour during a long bull market (1984–1989) to a long bear market (1990–1999). They identify differences in investing behaviour between the bull and the bear market, which are associated with poor investment performance. Based on the aforementioned studies I conclude that a full business cycle analysis is necessary when analysing investor stock market portfolio diversification.

The main contribution of the paper is the first empirical documentation of comprehensive educational characteristics, which influence investor diversification on the stock market including on bull and bear markets. In this paper I extend the documentation of previous studies and offer detailed empirical evidence that investors with higher academic education and top results in national exams in mathematics, mother tongue and geography hold more diversified portfolios. The same is true for investors who have the average score of more than 70 per cent in different high school exams. In addition, I conclude that investors holding a university degree in the natural sciences, mathematics or statistics hold more diversified portfolios. The opposite is true for investors with no academic degree and low performance in mathematics and mother tongue exams as they hold less diversified portfolios. The results for investors' risk-adjusted performance indicate that the economic costs of under-diversification is significant for most of the investors. Investors with under-diversified portfolios experience lower risk-adjusted performance on the stock market.

Many of my findings regarding control variables confirm results from the previous studies, indicating that investors on the Tallinn Stock Exchange have similar trading characteristics to investors in the rest of Europe, Asia or the USA. I provide empirical evidence that investors with higher numbers of transactions, as a proxy for experience, tend to hold more stocks in their portfolio. In addition, I show that greater portfolio size increases the average number of stock held in the portfolio. This finding is in line with Anderson (2007) and Goetzmann and Kumar (2008).

The second section provides an overview of previous studies. The third section offers insight into the unique dataset and provides the details of the methodology for measuring diversification and performance. The fourth section offers empirical evidence, results and robustness tests. The fifth section concludes.

2. Previous Studies

Investors are continually learning, gaining new knowledge and improving their knowhow about financial markets, but does it pay off to educate yourself? Many authors have found that education has a significant impact on investors' financial behaviour on the stock market and that learning eventually pays off. Nguyen and Schuessler (2012) argue that a higher level of education reduces behavioural biases such as the self-attribution bias, anchoring bias and representativeness, which contribute to better and more rational investment decisions.

Other authors claim that economic education increases financial awareness. Guiso and Jappelli (2005) provide empirical evidence that financial awareness is positively correlated with education, household resources, long-term bank relations and proxies for social interaction.

There is evidence that not only academic education, but also education obtained in the workplace and from other courses, improves investors' financial decisions. Bernheim and Garrett (2003) conclude that financial education in the workplace significantly increases the probability of savings in general, and the households which were exposed to financial courses during high school have higher savings rates than others. The educational environment where investors spend their time is an important factor influencing investment decisions and the choice to participate on the stock market. Vaarmets, Liivamägi, and Talpsepp (2014) show that higher education increases the probability of participation on the stock market.

Kumar (2009) sheds light on the reasons for the bad performance on the stock market of lower educated investors. The author finds that investors with a lower income and lower education level are more likely to choose lottery-type stocks or gamble on the stock market. Stock market gamblers are also rather younger and unemployed. Their portfolio performance is usually worse than average. This is consistent with evidence that financial decisions are influenced by age––older investors outperform younger investors. Additionally, female investors tend to experience better performance than male investors as they hold stocks longer and trade less as noted by Barber and Odean (2001) and Talpsepp (2010).

It is not only education itself, but also the quality and type of education, which contributes to better performance on the stock market as shown by Liivamägi, Vaarmets, and Talpsepp (2014). Gottesman and Morey (2006) add to this by demonstrating that fund managers who hold MBAs from schools ranked in the top 30 of the Business Week rankings of MBA programmes exhibit performance superior to the performance of both managers without MBA degrees and managers holding MBAs from unranked programmes. Additionally, they conclude that other education variables, such as whether the manager attained a CFA designation or holds either a non-MBA masters-level graduate degree or PhD, are generally unrelated to mutual fund performance.

Several authors conclude that education has a significant impact on investors performance, but does it also influence portfolio diversification? Rational investors should hold a diversified portfolio to minimize the impact of unnecessary volatility and risk on their investments. There are different opinions about how many stocks an investor should hold to have a well-diversified portfolio. Statman (1987) claims that individual investors should hold at least 30 stocks in their portfolio to have a well diversified portfolio. Evans and Archer (1968) conclude that a portfolio of at least ten stocks is enough to have the full benefits of diversification. In practice most investors worldwide hold under-diversified stock portfolios. Barber and Odean (2011) document that, on average, individual US investors in the LDB dataset hold only four stocks in their portfolio. The investors in the Estonian stock market hold in average 1.97 stocks in their portfolio, which is well below the considered optimal allocation of a well-diversified stock portfolio. One of the reasons is relatively small number of 23 different stocks available for investors in the Estonian stock market. Nevertheless investors holding fewer stocks than the average investor in their portfolio increases portfolio risk and reduces performance.

Investor behaviour on the stock market is not always rational and some of them over invest in the stock of their employer company, and therefore, are exposed to idiosyncratic

risk. Mitchell and Utkus (2003) demonstrate that far too many investors hold their 401(k) account investments in their employer's stock, and therefore, fail to diversify idiosyncratic risk. Poterba (2015) analyses the 20 largest defined contribution plans managed by corporations, and states that nearly half of the plan assets are invested in company stock. Benartzi (2001) documents that some of the allocation to company stock is voluntary on the part of employees.

Studies show that many investors tend to hold under-diversified portfolios, which adds additional economic cost to their wealth. Goetzmann and Kumar (2008) analyse the under-diversification of investors and find that investors tend to hold portfolios that are highly volatile and consist of stocks that are more highly correlated than one would expect when stocks were chosen randomly. They show that individual US investors hold under-diversified portfolios, where the level of under-diversification is greater among younger, low-income, less-educated and less-sophisticated investors. The level of under-diversification is also correlated with investment choices that are consistent with over-confidence, trend-following behaviour and local bias. In addition, French and Poterba (1991) find that investors prefer local and familiar stocks and avoid investment in foreign stocks, which provide more stronger diversification benefits.

Anderson (2007) ties individual investor portfolio diversification together by documenting that lower income, poorer, younger, and less well-educated investors invest a greater proportion of their wealth in individual stocks, hold more highly concentrated portfolios, trade more and have worse trading performance. They conclude that investors fail to take advantage of the benefits of diversification. This view is also shared by Goetzmann and Kumar (2008).

Many studies conclude that younger, low-income, less-educated and less-sophisticated investors tend to hold under-diversified portfolios and overinvest in their employee company stock, local stocks and domestic companies, which exposes them to greater risks which they are not compensated for. So far there have been studies analysing the overall educational impact on investors portfolio diversification, but none of them touched upon how comprehensive educational characteristics such as type or level of education and high school grades or final exams affect investor portfolio diversification. I am dealing with this issue by using a unique dataset from the Nasdaq OMX Tallinn and Estonian Ministry of Education and Research.

3. Data and Methodology

The unique dataset presented in this section helps to solve the complex puzzle of the relationship between detailed educational characteristics and portfolio diversification among investors on the stock market. For this study I use a comprehensive dataset from the only stock exchange in Estonia, Tallinn stock exchange, provided by Nasdaq OMX Tallinn. The data covers a period of nine years starting from 1 January 2004 to 31 December 2012 and includes all transactions made with listed Estonian companies. The period covers transactions for a total of 23 listed companies, which have been traded on the Estonian stock exchange during that period. The Nasdaq OMX Tallinn has a market capitalization of about 1.7 billion euros as of 31 December 2014.

Besides the data from the Nasdaq OMX Tallinn, I also use a unique dataset from the Estonian Ministry of Education and Research, which includes all high school grades and results of high school final exams from their implementation in 1997 till 2012. Descriptive

statistics about the average number of stocks in investors' portfolios by educational characteristics is presented in Table 1. Combining those unique datasets makes it possible to analyse different individual investor types based on gender, age, portfolio size, stocks holding period, number of transactions, level of education (high school, bachelor, master, doctor), distribution by type of education (physics, psychology, mathematics, economics, finance, medicine, law, information technology, public administration, chemistry), high school grades and high school ranks. The total number of observations of individual investors by gender, age, wealth, trading characteristics, for which the diversification by the number of stock holdings is measurable, is over 21,800. Table 1 presents the number of investor stock holdings in portfolios based on different educational characteristics.

During the observed period, investors hold on average 1.86 stocks in their portfolio, which is a relatively small number compared to the 23 different stocks available to investors. The total number of different investors who have made at least one purchase trade during the sample period is 33,843, of which 25,426 are individual investors. Of those investors, official educational characteristics for 8,450 investors are obtained and that forms the main sample for the analysis. Although the stock market data for the whole population is obtained, it is possible to tie educational data for only those investors whose data are in the educational register, which reduces the sample to about one third of all investors. As the national state exams and educational register did not exist before 1997, the sample consists of quite young investors, with an average age of about 33 years in 2012. Besides the 12-year age difference and portfolio size difference there are no material differences in investors trading characteristics such as number of transactions, portfolio diversification and portfolio turnover rate between the investor in the education sample and the average Estonian investor.

Different exam results are analysed separately and in a combined model, because each high school graduate has to take 3–5 state exams. The high school graduate has to take mandatory exams such as mathematics, mother tongue and English or German, while the other exams are optional. When more than one exam is included in the regression model multicollinearity starts to affect the results. It can be easily assumed that students who are good at a certain subject are also successful at other subjects; therefore, the resulting multicollinearity. To solve this problem, I construct a new variable called "egghead" and use it to represent a student who has national high school exam results over 70% of the maximum exam score on average. This new variable helps to eliminate any effects that could arise from obligatory and selective exam selection as this variable represents students with higher mental abilities. For all investors, the daily transaction date, the transaction price and the specific stock have been obtained. As the investors stock purchase prices before January 2004 have not been obtained, so the positions opened before that for any of the calculations are not used. Prices are adjusted for stock splits and dividends.

Table 1. Average Number of Stocks in Investors' Portfolios

		Average number of stocks in investors' portfolios						
				Percentiles				
Independent variables	Number of observations	Mean	Std. Dev.	10%	25%	50%	75%	90%
Mathematics exam bottom quartile	952	1.75	1.05	1	1	1.33	2.07	3
Mathematics exam top quartile	970	1.95	1.18	1	1	1.5	2.5	3.5
English exam bottom quartile	1,072	1.88	1.26	1	1	1.5	2.33	3.4
English exam top quartile	1,102	1.84	1.15	1	1	1.5	2.25	3.4
History exam bottom quartile	519	1.77	1.18	1	1	1.33	2	3.14
History exam top quartile	526	1.95	1.27	1	1	1.5	2.5	3.5
Mother tongue exam bottom quartile	1,319	1.76	1.12	1	1	1.29	2.03	3.08
Mother tongue exam top quartile	1,347	1.89	1.21	1	1	1.5	2.33	3.5
Physics exam bottom quartile	172	1.98	1.4	1	1	1.5	2.5	3.5
Physics exam top quartile	177	2.08	1.35	1	1	1.6	2.55	4
Geography exam bottom quartile	254	1.65	1.03	1	1	1	2	3
Geography exam top quartile	228	2.03	1.31	1	1	1.5	2.69	4
Egghead (exam high performers)	2,006	1.90	1.20	1	1	1.5	2.33	3.5
No egghead	3,548	1.80	1.15	1	1	1.33	2.11	3.21
Higher education	6,647	1.91	1.25	1	1	1.5	2.33	3.56
High school graduate, without a degree	1,803	1.7	1.06	1	1	1.25	2	3
Master's or doctoral degree	448	1.99	1.35	1	1	1.5	2.39	4
No master's or doctoral degree	8,002	1.86	1.21	1	1	1.43	2.25	3.43
Bachelor or equivalent degree	4,957	1.92	1.25	1	1	1.5	2.33	3.62
No bachelor or equivalent degree	3,493	1.78	1.16	1	1	1.33	2	3.11
Degree in natural sciences	997	2.02	1.29	1	1	1.6	2.5	3.86
No degree in natural sciences	7,453	1.84	1.2	1	1	1.4	2.2	3.4
Degree in humanities	389	1.94	1.3	1	1	1.5	2.28	3.69
No degree in humanities	8,061	1.86	1.21	1	1	1.45	2.25	3.43
Degree in social sciences	4,141	1.9	1.26	1	1	1.5	2.33	3.56
No degree in social sciences	4,309	1.82	1.17	1	1	1.4	2.17	3.33
Degree in mathematics or statistics	29	2.3	1.42	1	1	2	2.67	4.5
No degree in mathematics or statistics	8,421	1.86	1.21	1	1	1.46	2.25	3.44
Degree in economics	2,047	1.91	1.29	1	1	1.5	2.33	3.58
No degree in economics	6,403	1.85	1.19	1	1	1.46	2.2	3.4
Degree in medicine	124	1.75	1.01	1	1	1.42	2.07	3.06
No degree in medicine	8,326	1.87	1.22	1	1	1.47	2.25	3.46
Degree in public administration	162	1.92	1.27	1	1	1.41	2.25	3.8
No degree in public administration	8,288	1.86	1.21	1	1	1.47	2.25	3.44
Degree in finance	181	1.98	1.56	1	1	1.31	2.22	4
No degree in finance	8,269	1.86	1.21	1	1	1.5	2.25	3.44
Degree in information technology	586	1.95	1.29	1	1	1.5	2.33	4
No degree in information technology	7,864	1.86	1.21	1	1	1.44	2.25	3.43
Degree in physics, or chemistry, or biology	102	1.95	1.14	1	1	1.56	2.43	3.98
No degree in physics, or chemistry, or biology	8,348	1.86	1.22	1	1	1.45	2.25	3.44
Degree in law	398	1.9	1.24	1	1	1.5	2.33	3.38
No degree in law	8,052	1.86	1.21	1	1	1.44	2.25	3.46
Degree in psychology	58	1.7	0.86	1	1	1.44	2.22	3.08
No degree in psychology	8,392	1.86	1.22	1	1	1.47	2.25	3.45
Male	5,532	1.89	1.21	1	1	1.50	2.33	3.5
Female	2,918	1.72	1.13	1	1	1.14	2	3

Note: Table 1 reports average number of stocks in investors' portfolios divided between the following educational categories: national high school exam results, level and type of education. The Table reports the number of observations, mean number of stocks, standard deviation and percentile allocation of stocks based on investors' characteristics.

Source: Author's calculations

Investor diversification is measured on the basis of the average number of stocks held by an investor in their portfolio, as suggested by Anderson (2007). The dependent variable is a categorical variable based on the average number of stocks in the investor portfolio. The dependent variable is divided into equally distributed thirds, as a quartile or higher distribution is statistically or economically not reasonable due to the relatively small average number of stocks held in investors' portfolios. The range of average stocks held in investors' portfolios varies for the lowest diversification category from 1.00 to 1.39 stocks, for the medium diversification category from 1.40 to 2.32 and for the high diversification category from 2.33 to 17. On average, investors hold 1.97 stocks in their portfolio. As a robustness check, I use a diversification ratio, which is defined as market portfolio return standard deviation divided by investor portfolio return standard deviation motivated by the discussion by Goetzmann and Kumar (2008). The diversification ratio means that the lower the number of stocks in an individual investor portfolio the higher the volatility and risk in the portfolio, which results in a lower calculated diversification ratio. Control variables, such as gender, age, wealth, experience and trading characteristics are derived based on documentation from Anderson (2007) and Goetzmann and Kumar (2008). Most of the independent variables are binary.

The study uses probability models to analyse the effect of educational characteristics on portfolio diversification and performance. Investors are divided in equally distributed thirds according to the average number of stocks held in their portfolios. For this kind of data analysis the ordered logit regression model has been used as suggested by Coval and Shumway (2005), Greene (1997), Gelman and Hill (2007) and van Dijk and Pellenbarg (2000). As a robustness test, the study uses the OLS regression models to analyse the effect of educational and other characteristics on different diversification groups separately and to confirm the results of the ordered logit regression model.

Aggregate data is used to provide an indicator for the average return during the observed period for investors. As investors can also trade foreign stocks and increase or decrease the amount invested, which has an effect on performance, portfolio return is calculated as an annual money-weighted return. Each transaction has been adjusted for transaction costs of five euros + 0.1% * (transaction amount). As discussed by Markowitz (1991) and Modigliani and Modigliani (1997), to have true picture of investor performance, the risk, which is associated with a particular investment, should be taken into account. Therefore, each individual's risk-adjusted returns are calculated because some investors might intentionally take higher risks in order to achieve higher returns.

For the risk-adjusted performance measurement, a risk-adjusted return is used as defined by Modigliani and Modigliani (1997). They chose standard deviation as a measure of risk, and return as a measure of reward, deriving equations accordingly. From the discussion by Goetzmann and Kumar (2008) and Sharpe (1966), investor Sharpe ratios are calculated and compared for robustness check purposes.

4. Empirical Results

This section presents the empirical results indicating that investors with higher academic education and top results in national exams in mathematics, mother tongue and geography hold more diversified portfolios. The same is true for investors with national high school exam results averaging above 70% of maximum exam score. In addition, I conclude that

investors with a university degree in natural sciences, mathematics or statistics hold more diversified stock portfolios compared to investors with no such educational characteristics. The opposite is true for investors with no academic degree and low performance in mathematics and mother tongue exams as they hold less diversified portfolios. Analysing investors' risk-adjusted performance reveals that higher portfolio diversification is a significant factor contributing to higher returns on the stock market.

4.1. Do Top Performing Investors in High School National Exams Hold More Diversified Portfolios?

This section offers empirical evidence supporting the hypothesis that investors with higher high school exam results hold more diversified portfolios. In general, the conclusion is that investors with high national exam results in mathematics, mother tongue and geography hold more diversified stock portfolios. The opposite is true for investors demonstrating poor results in national exams in mathematics and mother tongue.

To test the hypothesis that investors with higher high school exam results hold more diversified portfolios, the study uses an ordered logit regression model. I start with single ordered logit regressions to study the single effects of educational variables on portfolio diversification and then introduce a number of control variables (demographic, wealth, experience, trading behaviour). Due to multicollinearity between educational characteristics, regression models with control variables are analysed individually and are not combined in one model. At first the top performers in high school mathematics together with control variables are studied and no other high school exam results are included in the model. After that an ordered logit regression is repeated for all educational characteristics. The statistical significance for control variable coefficients in regressions results does not differ for different educational characteristics. The results for all control variable regressions are available upon request. The results are reported for the most relevant national exams and specialist university fields determined based on the exam participation rate.

Table 2. Ordered Logit Regression Model for Investor Portfolio Diversification and Educational Characteristics

Independent variables	Individual variables		High school exam results and control variables		Level of education and control variables		Type of education and control variables	
	Odds ratio	z-value	Odds ratio	z-value	Odds ratio	z-value	Odds ratio	z-value
Mathematics exam top quartile	1.31***	3.93	1.34***	3.83				
Mathematics exam bottom quartile	0.82***	-2.80	0.83**	-2.39				
Physics exam top quartile	1.14	0.82	1.48**	2.21				
Physics exam bottom quartile	0.86	-0.91	0.84	-0.95				
Mother tongue exam top quartile	1.15**	2.38	1.12*	1.77				
Mother tongue exam bottom quartile	0.81***	-3.47	0.81***	-3.22				
English exam top quartile	1.06	0.85	1.09	1.20				
English exam bottom quartile	1.10	1.50	0.99	-0.07				
History exam top quartile	1.14	1.38	1.03	0.27				
History exam bottom quartile	0.80**	-2.39	0.89	-1.13				
Geography exam top quartile	1.63***	3.38	1.40**	2.17				
Geography exam bottom quartile	0.70**	-2.53	0.85	-1.06				
Eggheads (exam high performers)	1.18***	3.20	1.17***	2.88				
Higher education	1.33***	5.67			1.23***	3.70		
Master's or doctoral degree	1.20**	2.01			1.02	0.14		
Bachelor or equivalent degree	1.25***	5.26			1.11**	2.36		
High school graduate	0.75***	-5.67			0.82***	-3.70		
Natural sciences degree	1.36***	4.99			1.22***	2.89		
Humanities degree	1.04	0.44			1.09	0.86		
Social science degree	1.09**	2.11			0.99	-0.15		
Degree in economics	1.04	0.85					0.98	-0.43
Degree in public administration	0.99	-0.10					1.00	-0.01
Degree in finance	0.89	-0.83					0.95	-0.31
Degree in information technology	1.09	1.06					1.03	0.30
Degree in math or statistics	2.19**	2.27					2.34**	2.32
Degree in physics, or chemistry, or biology	1.27	1.29					1.36	1.64
Degree in law	1.12	1.21					1.02	0.19
Degree in medicine	0.93	-0.43					0.99	-0.08
Degree in psychology	0.93	-0.30					0.93	-0.27
Male			1.17*	1.68	1.19***	3.12	1.18***	3.03
Birth year			0.99	-1.02	1.00	0.48	1.00	0.11
Total number of transactions			1.06***	19.36	1.06***	29.7	1.06***	29.72
Average portfolio size			1.00***	8.56	1.00***	10.36	1.00***	10.44
Average holding period			1.00***	7.33	1.00***	10.1	1.00***	10.11
Log likelihood			-3353		-7340		-7342	
Pseudo R^2			0.14		0.14		0.14	

Note: Table 2 reports coefficients and z-values from an ordered logit regression with robust standard errors in which the categorical dependent variable takes the value 1 to 3, depending on number of stocks held in the investors' portfolio. The first column presents independent dummy variables. The other columns present multiple regression results. Because of multicollinearity, the second, third and fourth column regressions are run individually together with control variables. In this table control variable coefficients for the second column are presented for top mathematics exam results, for the third column higher education and for the fourth column investors holding a degree in economics. The statistical significance of other regression control variable coefficients does not differ and are available upon request. Odds ratios are presented to simplify the interpretation. If the odds ratio > 1, it means increased probability of belonging to the particular group because of the factor. Coefficients denoted with *, ** and *** are significant at the 10%, 5% and 1% level respectively.

Source: Author's calculations

The Table 2 results show that investors in the top quartile of national high school exam results have an odds ratio above one indicating that top national exam performers hold more diversified portfolios. Table 1 shows that the average stocks held in portfolios is higher for investors performing better in national high school exams with the only exception being English exam results. The average number of stocks held in investors' portfolios for top performers in national high school exams are as follows: mathematics – 1.95, mother tongue – 1.89, history – 1.95, physics – 2.08 and geography – 2.03. The average number of stocks held in investors' portfolios for low performers in national high school exams are as follows: mathematics – 1.75, mother tongue – 1.76, history – 1.77, physics – 1.98 and geography – 1.65. The only exception is the English exam, with investors' average stocks in portfolios of 1.84 for exam high performers and 1.88 for low performers. The statistically significant educational variables for single and combined regression are mathematics and mother tongue top and bottom quartiles, and geography top quartile results, which are used for further analysis.

Including different control variables in the regressions does not change the interpretation of the educational factors (the odds-ratio does not change from above one to be below one or vice versa), but some educational characteristics being statistically significant in the single ordered regression model are not significant in the model with the control variables. For further interpretation, the study uses only those results, which are statistically significant for both regressions. The choice of control variables was made based on the findings of Anderson (2007) and Goetzmann and Kumar (2008). Such studies show that demographic variables, wealth, experience and trading characteristics influence portfolio diversification and portfolio performance and should be considered in analyses. The analysis of the control variables is discussed in more detail in section 4.3.

The results in Table 2 for single and combined ordered logit regression show that only top and bottom quartiles for the mathematics and mother tongue exam and the top quartile for the geography exam are statistically significant. The top quartile results for the mathematics exam and bottom quartile for the mother tongue exam are statistically significant at the 1% level. The bottom quartile results for the mathematics exam and top quartile for the geography exam are statistically significant at the 5% level and the top quartile results for the mother tongue exam are statistically significant at the 10% level for the combined regression. The odds ratio in Table 2 column 1 and 2 for top performers in the mathematics and mother tongue high school exams are both ordered logit regressions over one (for the mathematics exam the single regression odds-ratio is 1.31 and the odds-ratio with control variables is 1.34 and for the mother tongue exam the single regression odds-ratio is 1.15 and the odds-ratio with control variables is 1.12), indicating that investors belonging to those groups hold more diversified portfolios. The marginal effect analysis for investors presented in Table 3 indicates that the probability of holding more diversified portfolios increases by 5.12% for top performers in the national high school mathematics exam and by 2.61% for top performers in the mother tongue exam. For investors belonging to the top performers in the geography exam, an odds-ratio above one indicates that investors belonging to this group hold more diversified portfolios. In particular, they have 8.74% higher probability of belonging to the group of high diversifying investors.

Table 3. Marginal Effect Analysis for Investor Portfolio Diversification Categories

	Low		Medium		High	
Independent variables	I category		II category		III category	
	Coefficients	z-values	Coefficients	z-values	Coefficients	z-values
Marginal effect for high school exam results						
Mathematics exam top quartile	-6.73%***	-3.96	1.61%***	4.31	5.12%***	3.80
Mathematics exam bottom quartile	4.94%***	2.80	-1.42%***	-2.59	-3.52%***	-2.87
Mother tongue exam top quartile	-3.51%**	-2.39	0.90%**	2.50	2.61%**	2.34
Mother tongue exam bottom quartile	5.24%***	3.48	-1.52%***	-3.22	-3.72%***	-3.57
Geography exam top quartile	-12.09%***	-3.42	3.35%***	3.79	8.74%***	3.17
Eggheads (exam high performers)	-4.19%***	-3.21	1.14%***	3.28	3.04%***	3.16
Marginal effect for education level						
Higher education (dummy)	-7.14%***	-5.70	2.14%***	5.11	5.00%***	5.93
Bachelor or equivalent degree	-5.47%***	-5.27	1.51%***	5.04	3.96%***	5.31
High school graduate	7.14%***	5.70	-2.14%***	-5.11	-5.00%***	-5.93
Natural sciences degree	-7.71%***	-5.06	1.69%***	6.35	6.02%***	4.74
Marginal effect for education type and control variables						
Degree in mathematics or statistics	-18.47%**	-2.53	1.61%	1.55	16.86%**	2.02

Note: Table 3 reports coefficient probabilities and z-values from an ordered logit regression marginal analysis for the discrete change in the dummy variable from 0 to 1. The 1st category represents the lowest and the 3rd category the highest level for investor portfolio allocation. Coefficients denoted with *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

Source: Author's calculations

Table 2 and Table 3 indicate that the opposite is true for investors demonstrating low results in national exams in mathematics and mother tongue. The odds ratio for low performers in the mathematics and mother tongue exam is below one for both regressions (for the mathematics exam the single regression odds-ratio is 0.82 and odds-ratio with control variables is 0.83, and for the mother tongue exam the single regression with control variables odds-ratio is 0.81), indicating that investors belonging to those groups hold less stocks in their portfolios. The marginal effect analysis for those investors indicates that the probability of holding less diversified portfolios increases by 4.94% for low performers in the mathematics exam and by 5.24% for low performers in the mother tongue exam.

For investors belonging to the egghead category, the story confirms prior findings. That is, the egghead category is statistically significant at the 1% level and has an odds-ratio in the single ordered logit regression of 1.18 and an odds-ratio with control variables of 1.17. Those results indicate that investors belonging to the egghead group have a higher probability of holding diversified portfolios compared to investors with no such educational characteristics. The marginal effect analysis for investors belonging to the egghead category indicates that the probability of holding diversified stock portfolio increases by 4.19% if the investor belongs to this category. The eggheads have on average 1.90 stocks in their portfolios compared to the average of 1.80 stocks for investors not belonging to this category. The relationship between portfolio diversification and stock market performance is discussed in detail in section 4.4.

4.2. Do Investors with an Academic Degree Hold More Diversified Portfolios?

This section offers empirical evidence supporting the hypothesis that investors with a higher academic education hold more diversified portfolios and high school graduates without an

academic degree tend to diversify their stock portfolios less. Regarding the type of education, investors with a degree in mathematics or statistics tend to have more diversified portfolios than investors with no such degree.

The study uses the same control variables (demographic, experience, wealth, trading style) in the ordered logit regressions for university degree and level of education as for the previous analysis. I collected all the available data on university degree types held by investors and generalized and grouped them into different categories according to the names of the university programmes. The results show that investors with a degree in mathematics or statistics hold more diversified portfolios. The odds ratio for mathematics or statistics degree holders is over one for both ordered logit regressions (the single regression odds-ratio is 2.19 and the odds-ratio with control variables is 2.34), indicating that investors with this degree tend to hold more stocks in their portfolios. The marginal effect analysis indicates that the probability of belonging to the highest diversifying investor group increases by 16.86% if the investor has a mathematics or statistics degree. Investors with a mathematics or statistics degree have on average 2.30 stocks in their portfolios compared to the average of 1.86 stocks in the portfolios for investors not belonging to this category. Degrees in law, public administration, economics, physics, medicine, information technology, finance, psychology nor any of the natural science fields seem to be statistically significant.

The results for the level of education shows that investors with a higher education have an odds ratio above one indicating that investors with an academic university degree hold more diversified portfolios. The odds ratio for investors with a higher education is over one for both ordered logit regressions (the single regression odds-ratio is 1.33 and the odds-ratio with control variables is 1.23), indicating that investors with a higher education have more diversified portfolios. Analysing high school graduates, bachelor and master's or doctoral degree holders separately, and the results show that investors with only a high school graduate diploma have an odds ratio below one, indicating that investors with such educational characteristics have less diversified portfolios. The odds ratio for investors holding only a high school graduate diploma for a single regression is 0.75 and for the regression with control variables is 0.82. The marginal analysis results show that the probability of the investor belonging to the lowest diversifying investors group increases by 7.14% if the investor has no academic degree. Investors with only a high school diploma have on average 1.70 stocks in their portfolios compared to the average of 1.91 stocks in portfolios for investors with a higher academic education.

Table 2 reports that investors with a bachelor degree have an odds ratio above one indicating that investors with such a university degree have more diversified portfolios than investors with no such educational characteristics. The odds ratio for investors with a bachelor degree for a single regression is 1.25 and the odds-ratio for the regression with control variables is 1.11. The marginal analysis indicates that the probability of the investor belonging to the highest diversifying investors group increases by 3.96% if the investor has a bachelor or equivalent degree. Investors with a bachelor or equivalent degree have on average 1.92 stocks in their portfolios compared to the average of 1.78 stocks in portfolios for investors with no such educational characteristics. Holding a master's or doctoral degree is not statistically significant in the model combined with control variables, and therefore, no conclusion can be drawn for this level of education. Still, investors with a master's or doctoral degree on average have 1.99 stocks in their portfolios compared to the average of 1.78 stocks in portfolios for investors without this degree.

Analysing the results for education level by the type of science, the results indicate that investors with a degree in natural sciences are statistically significant and have an odds ratio above one showing that investors with such a university degree have more diversified portfolios. The odds ratio for investors with a degree in natural sciences for the single regression is 1.36 and for the regression with control variables is 1.22. The marginal analysis confirms that the probability of the investor belonging to the highest diversifying investors group increases by 6.02% if the investor has a natural sciences degree. Investors with a degree in the natural sciences on average have 2.02 stocks in their portfolios compared to the average of 1.84 stocks in portfolios for investors without such educational characteristics. Social and humanities sciences degrees are not statistically significant for investor portfolio diversification.

There could be several reasons why investors with higher academic degrees show better portfolio diversification on the stock market. By analysing university curricula one reason for better portfolio diversification among mathematics or statistics degree holders as well as for investors with a degree in the natural sciences is that these degrees provide stronger analytical skills. These skills can help them to better understand and analyse financial information and make more accurate analyses by having a deeper understanding of the numbers. One possible reason why investors with a university degree have more diversified portfolios can be connected with their higher intellectual abilities, which are further enhanced during their university student years, regardless of what they study. Higher intellectual abilities come with the potential for analysing financial markets and related risks together with portfolio diversification. The view that a higher level of education helps investors make more rational investment decisions is supported by Grinblatt, Keloharju, and Linnainmaa (2012). The relationship between portfolio diversification and stock market performance is discussed in detail in section 4.4.

4.3. Other Factors Influencing Investor Portfolio Diversification

Besides educational variables, the study uses a number of control variables to test the effect of other possible factors on investor portfolio diversification. When including continuous control variables (such as birth year, total number of transactions, average portfolio size or average holding period), educational factors and control variables remain significant, but the odds-ratios for control variables remain qualitatively very near to one. The story behind the control variables is slightly complicated.

Feng and Seasholes (2005) suggest using the total number of transactions as a measure of investor experience. An odds-ratio above one for the control variable indicates that more experience tends to increase investor portfolio diversification. On the other hand, Barber and Odean (2000) use the same variable as a proxy for trading too much. By analysing the number of transactions and dividing the continuous control variable into seven groups, I see that the average number of stocks held in portfolios increases as the number of transactions increases. But for investors who have made more than 100 transactions, the average number of stocks in the portfolio decreases, suggesting that investors trading actively hold less diversified portfolios. Such a finding seems to be consistent with both of the mentioned references. This control variable remains significant in all of the model setups.

The level of wealth seems to be clearly an important factor for portfolio diversification. The average portfolio size was used as a proxy for wealth. The study shows that greater portfolio size increases the average number of stock held in the portfolio. Also, the fact that

the control variable coefficient is above 1 and statistically significant indicates that investors with greater portfolio size hold more stocks in their portfolios. This finding is in line with the findings of Anderson (2007) and Goetzmann and Kumar (2008). In addition, the average holding period has a positive effect on investor portfolio diversification as the control variable coefficient reported in Table 2 is above one. The demographic control variables together with educational variables show that birth year is statistically not significant. This result is expected as the average age of investors is quite young due to the availability of the education data. On the other hand, the gender variable is statistically significant, and has an odds-ratio above one indicating that male investors tend to hold more diversified portfolios over female investors. Male investors have on average 1.89 stocks in their portfolios compared to females with 1.72 stocks in theirs.

4.4. Economic Impact and Cost of Under-Diversification

To test what effect the under-diversification has on investors' portfolios, I compare their risk-adjusted performance. To evaluate the economic cost of under-diversification, I examine the relationship between portfolio diversification and portfolio risk-adjusted performance. I calculate and compare two different performance measures: annual risk-adjusted performance and Sharpe ratio. Table 4 presents the performance measures for different portfolio diversification groups of investors. The results for the full period from 2004 to 2012 indicate that investors with more diversified portfolios experience higher risk-adjusted performance and higher Sharpe ratios. Investors belonging to the group of lowest portfolio diversification have an annual risk-adjusted return in the 50th percentile – 1 per cent compared to investors risk-adjusted return of 0 per cent and 1 per cent in the medium and high diversification group. This means that investors with low diversification lose 2 percentage points of risk-adjusted performance annually compared to investors with higher portfolio diversification.

The strongest difference in risk-adjusted performance can be observed in the first bull market from 1 January 2004 to 05 February 2007, where investors belonging to the lowest portfolio diversification group have an annual risk-adjusted return in the 50th percentile – 12 per cent compared to investors risk-adjusted returns of 28 per cent and 39 per cent in the medium and high diversification groups. In the subsequent bear market from 6 February 2007 to 9 March 2009 and bull market from 10 March 2009 to 31 December 2012, the economic effect exists between the group of investors with the lowest and highest diversification, but is not so strong, being in range of 1–2 percentage points. The Sharpe ratio analysis presented in Table 4 confirms the previous statements.

The study conducted a regression analysis to assess the statistical significance of the risk-adjusted performance results in Table 4. The regression coefficients for the risk-adjusted performances for the lowest diversification groups were statistically significant at the 5% level and negative, indicating that investors belonging to the lowest diversification groups during the four periods observed received lower risk-adjusted returns on the stock market. By contrast, the regression coefficients for the risk-adjusted performances for the highest diversification groups were statistically significant at the 5% level and positive, indicating that investors belonging to the highest diversification groups during the four periods observed received higher risk-adjusted returns on the stock market. The regression results indicate that higher portfolio diversification has a positive and statistically significant influence on the investors' risk-adjusted performances, which has also been previously noted by Goetzmann and Kumar (2008).

More detailed empirical analysis regarding investor education and risk-adjusted performance has been done by Liivamägi, Vaarmets, and Talpsepp (2014), who used the same dataset and provided empirical evidence that the level and type of education affect performance on the stock market. The focus of this study is to analyse investor portfolio diversification and its overall relationship to risk-adjusted performance.

Table 4. Investors Risk-Adjusted Performance and Sharpe Ratio on the Stock Market

	Lowest diversification				Medium diversification				Highest diversification			
	Number of obs.	25th %ile	50th %ile	75th %ile	Number of obs.	25th %ile	50th %ile	75th %ile	Number of obs.	25th %ile	50th %ile	75th %ile
Panel A Risk-adjusted performance												
Period 2004 - 2012	14,435	-8%	-1%	11%	10 705	-6%	0%	13%	11 329	-5%	1%	12%
Period 2004 - 2007	7,941	11%	12%	44%	5 308	12%	28%	76%	5 657	16%	39%	80%
Period 2007 - 2009	4,626	-51%	-42%	-30%	4 748	-52%	-43%	-32%	5 983	-52%	-43%	-34%
Period 2009 - 2012	4,460	-3%	8%	22%	4 858	-1%	9%	21%	6 446	1%	10%	21%
Panel B Sharpe ratio												
Period 2004 - 2012	14,479	-0.78	-0.31	0.19	10 733	-0.52	-0.19	0.26	11 337	-0.49	-0.19	0.23
Period 2004 - 2007	7,965	-0.91	-0.82	0.60	5 334	-0.82	-0.16	1.64	5 664	-0.82	0.21	2.01
Period 2007 - 2009	4,657	-0.77	-0.6	-0.18	4 771	-0.76	-0.52	-0.08	6 011	-0.77	-0.52	-0.10
Period 2009 - 2012	4,514	-0.79	-0.14	0.53	4 895	-0.75	-0.15	0.48	6 516	-0.73	-0.21	0.45

Note: Table 4 reports investors annual risk-adjusted performance (Panel A) and Sharpe ratio (Panel B) according to portfolio diversification. Investors are divided into groups by portfolio diversification level: low, medium and high diversification groups. The table reports investors' risk-adjusted performance and Sharpe ratios based on the business cycle. In the first row the performance is reported for the full period; in the second row for the bull market period from 01.01.2004 to 05.02.2007; in the third row for the bear market period from 06.02.2007 to 09.03.2009; in the fourth row for the bull market period from 10.03.2009 to 31.12.2012. The table reports percentile allocations of investors risk-adjusted performance and Sharpe ratio based on investor portfolio diversification.

Source: Author's calculations

Overall, the results for risk-adjusted performance indicate that the economic cost of under-diversification is significant for most investors. Investors with under-diversified portfolios experience higher volatility and lower risk-adjusted performance on the stock market for which they are not compensated. The findings are consistent with those of Brennan and Torous (1999). Another conclusion derived from Table 4 is that only the top 25 per cent of investors during the full business cycle show positive Sharpe ratios, meaning that the rest of the investors would be better off just investing in risk-free assets and not selecting individual stocks at all. Those remaining 75 per cent of investors earn lower returns than the risk-free rate, while taking considerable risks during the observed period.

4.5. Robustness Checks

To verify the robustness of the results, the study conducted a number of additional analyses. The ordered logit regression models for the diversification ratio was estimated. Those results are available upon request. Lower numbers of stocks in individual investor portfolios result in higher volatility in the portfolio, which results in a lower calculated diversification ratio. For the diversification ratio, the same model setup was used as for the average stock in

portfolio, except the ordered logit regression model was divided to quartiles. The results from the diversification ratio confirm the findings presented in Table 2. In addition, the study used OLS regressions (see Table 5) instead of ordered logit, although the latter should be preferred for the task. The results of the OLS regressions using control variables confirm the results presented in Table 2. For the empirical model, the study derived control variables, such as gender, age, wealth, experience and trading characteristics, based on documentation from Anderson (2007) and Goetzmann and Kumar (2008).

The robustness test results reported in Table 5 confirm the findings from Table 2 that investors with top results in national exams in mathematics, mother tongue and geography have more diversified portfolios. In addition, investors who belong to the egghead category tend to have more diversified stock portfolios. Investors with a higher academic education, bachelor degree and university degree in the natural sciences, mathematics or statistics diversify their stock portfolios more. The opposite is true for investors with no academic degree and low performance in mathematics and mother tongue exams as they hold less diversified portfolios.

Table 5. Regression Results for Investor Diversification and Educational Characteristics

Independent variables	Lowest diversification		Medium diversification		Highest diversification	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Panel A. Regression results without control variables						
Mathematics exam top quartile	-0.07***	-3.79	0.02	1.38	0.05***	2.97
Mathematics exam bottom quartile	0.05***	2.68	-0.02	-0.93	-0.03**	-2.15
Mother tongue exam top quartile	-0.04***	-2.60	0.02*	1.66	0.02	1.31
Mother tongue exam bottom quartile	0.05***	3.42	-0.02	-1.43	-0.03**	-2.51
Geography exam top quartile	-0.11***	-2.78	0.00	-0.13	0.11***	3.53
Eggheads (exam high performers)	-0.04***	-2.89	0.01	0.60	0.03***	2.78
Higher education	-0.06***	-4.84	0.00	0.17	0.06***	5.49
Bachelor or equivalent degree	-0.05***	-4.79	0.01	1.04	0.04***	4.51
High school graduate	0.06***	4.84	0.00	-0.17	-0.06***	-5.49
Natural sciences degree	-0.08***	-5.01	0.03**	2.22	0.05***	3.54
Degree in mathematics or statistics	-0.18*	-1.92	0.01	0.06	0.17**	2.18
Panel B. Regression results with control variables						
Mathematics exam top quartile	-0.06***	-3.60	0.02	1.17	0.04***	2.98
Mathematics exam bottom quartile	0.05***	2.57	-0.01	-0.82	-0.03**	-2.14
Mother tongue exam top quartile	-0.04***	-2.85	0.03**	2.15	0.01	1.02
Mother tongue exam bottom quartile	0.05***	3.44	-0.02*	-1.66	-0.03**	-2.27
Geography exam top quartile	-0.07*	-1.86	-0.01	-0.25	0.07***	2.58
Eggheads (exam high performers)	0.01	1.57	-0.02*	-1.89	0.00	0.14
Higher education	-0.05***	-3.50	0.00	0.06	0.05***	4.14
Bachelor or equivalent degree	-0.04***	-3.57	0.01	0.96	0.03***	3.22
High school graduate	0.05***	3.50	0.00	-0.06	-0.05***	-4.14
Natural sciences degree	-0.07***	-4.01	0.03*	1.90	0.04***	2.69
Degree in mathematics or statistics	-0.18**	-2.08	0.01	0.09	0.18**	2.40
Male	-0.07***	-3.44	0.03*	1.69	0.04**	2.19
Birth year	0.00	1.65	0.00	-0.84	0.00	-1.02
Total number of transactions	0.00***	-16.57	0.00	1.53	0.00***	18.11
Average portfolio size	0.00***	-7.74	0.00*	-1.81	0.00***	11.34
Average holding period	0.00**	-2.43	0.00***	-3.30	0.00***	6.68

Note: Table 5 reports regression results for investors diversification and educational characteristics for statistically significant independent variables derived from Table 2. Table 5 reports coefficients and t-values from an OLS regression for different educational characteristics without control variables (Panel A) and with control variables (Panel B). The columns are presented based on investors diversification. Coefficients denoted with *, ** and *** are respectively significant at the 10%, 5% and 1% level.

Source: Author's calculations

5. Conclusion

Many authors have concluded that investors hold under-diversified portfolios, which contribute to unnecessary risk taking and lower stock market performance on the stock market. Still some investors successfully avoid under-diversification and demonstrate higher risk-adjusted returns on the stock market. With the help of a unique dataset, I provide empirical evidence to the complex puzzle of how comprehensive educational characteristics influence investor portfolio diversification with stock market performance during the full business cycle.

The main aim of this paper is to provide empirical results showing how educational characteristics affect investor portfolio diversification on the stock market during the full business cycle from 2004 to 2012. I present empirical evidence confirming that investors with a higher academic education and top national high school exam results in mathematics, mother tongue and geography have more diversified portfolios. The same is true for investors who have the average score in different high school exams above 70 per cent of the maximum exam score. By contrast, investors demonstrating low results in mathematics and mother tongue high school exams hold less stocks in their portfolio. In addition, I show that investors with a bachelor degree or a degree in the natural sciences, mathematics or statistics diversify their stock portfolios more than investors with no such educational characteristics. The opposite is true for investors with no academic degree as they have less diversified portfolios.

The results for investors risk-adjusted performance indicate that the economic costs of under-diversification is significant for most of the investors. Investors with under-diversified portfolios experience lower risk-adjusted performance on the stock market for which they are not compensated. Another conclusion is that only the top 25 per cent of investors show positive Sharpe ratios, meaning that the rest of the investors would be better off just investing in risk-free assets and not selecting individual stocks at all. These remaining 75 per cent of investors earn lower annual returns during the full business cycle than the risk-free rate, while taking considerable risks during the observed period.

Many of my findings regarding control variables confirm results from previous studies, including that investors with a greater number of transactions, as a proxy for experience, tend to increase investor portfolio diversification. In addition, my empirical results suggest that greater portfolio size increases the average number of stocks held in the portfolio. Having provided empirical evidence that the level and type of education influences investor portfolio diversification on the stock market, it would be interesting to study whether the level and type of education have an effect on investor trading behaviour.

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PAPER II

INVESTOR EDUCATION AND TRADING ACTIVITY ON THE STOCK MAKRET

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Investor education and trading activity on the stock market

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ABSTRACT

This study analyses how investors' educational characteristics affect their trading activity on the stock market. It uses a unique dataset from the Tallinn Stock Exchange, covering all transactions of a full business cycle from 2004 to 2012, along with a dataset containing the official educational background for all individual investors. Applying an ordered logit regression model and controlling for gender, age, wealth, portfolio diversification and average stock holding period, this study provides empirical evidence that the investors with top results in national exams or the investors holding an academic degree trade stocks more actively. The opposite is true for the investors with no academic degree as they trade stocks less actively. Analysing investors' risk-adjusted performance reveals that trading experience in the form of trading activity is the contributing factor for higher returns on the stock market.

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1. Introduction

One might think that investing on the stock market is a difficult task and therefore the individual would assess one's abilities rationally. The empirical evidence suggests the opposite as the investors tend to oversimplify the situations that lead to mistakes in the investment decision process (Shefrin, 2002). Still, making mistakes is not so costly for the investors' wealth. Nicolosi, Peng, and Zhu (2009) posit that investors do learn from mistakes and their trading experience improves performance on the stock market. In order to understand investors' behaviour and financial decisions on the stock market, it is important to determine whether investors' education affects trading activity.

Education is a significant component, which among other factors influences investors' performance, risk-taking and stock market participation. Campbell (2006) notes that educated investors participate more actively on the stock market and they tend to make more rational investment decisions than investors with lower educational level. Besides stock market participation choices, education is considered a key element explaining investors' risk-taking behaviour. Grable (1998) provides empirical evidence that education appears to encourage risk taking and offers a possible explanation that higher level of academic education allows individuals to assess risk and benefits more adequately compared to investors with a lower educational level. Goetzmann and Kumar (2008) find that investors

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who are younger, have lower income, are less-educated, and less-sophisticated, tend to hold portfolios that are highly volatile and consist of stocks that are more highly correlated compared to stocks, which were chosen randomly. Anderson (2007) adds to this viewpoint by stating that less-educated investors invest a greater proportion of their wealth in individual stocks, hold more highly concentrated portfolios and have worse trading performance.

Several authors state that besides academic education, real-life trading experience helps to achieve better performance on the stock market. Dhar and Zhu (2006) provide empirical evidence that trading experience helps investors to reduce certain behavioural biases and that investors' trading improves over time. Feng and Seasholes (2005) use the number of trades as a proxy for investor experience and find that investors do learn from their trading experience. Education is considered an important characteristic explaining investors' stock market participation choices, performance and risk-taking decisions on the stock market. Assessing the impact of education on investor trading experience in the form of trading activity, would be important in understanding investors' financial decision-making process.

The aim of the paper is to study how educational characteristics influence investors' trading activity and whether investors benefit from their trading experience. This study uses the number of trades as a proxy for investors' trading activity and trading experience. Nguyen and Schuessler (2012) state that a higher level of education reduces behavioural biases such as self-attribution bias, anchoring bias and representativeness and helps to make more rational investment decisions. Hence, this study formulates the hypothesis that investors with good results in national state administrated high school exams and investors with higher level of education trade more on the stock market. The rationale for those investors executing more trades to a certain extent is to gain practical experience and use this experience to achieve higher risk-adjusted returns on the stock market.

Liivamägi, Vaarmets, and Talpsepp (2014) find that the level and type of education affect investment decisions and performance on the stock market. Christiansen, Joensen, and Rangvid (2008) propose that financial decisions are influenced by the type of education and show that individuals who obtained university degree in economics, have higher tendency to hold stocks. Hence, the paper studies the effects of the education level and type (specialty) on investors' trading activity.

Prior researchers show that education is a key factor explaining investors' stock market behaviour, but to due to the limitation of data availability they have used only education level as an explanatory variable. This study uses a unique dataset of detailed educational characteristics such as national exam results, university degree, specialty and education type to address the research gap in the literature. The main contribution of the paper is the first empirical documentation of comprehensive educational characteristics which influence investors' trading activity on the stock market.

This paper attempts to extend the documentation of previous studies and offers detailed empirical evidence that investors with an academic degree and top results in national exams are more likely to trade actively on the stock market. In addition, the paper concludes that investors with a university degree, a synonym for an academic degree, in natural sciences trade more actively compared to the investors with no such degree. The opposite is true for the investors with no academic degree and for the investors with poor performance in geography exam results as they execute a lower number of

trades. As regards the type of education, the empirical finding is that the investors holding a degree in medicine are more likely to trade less compared to investors with no such degree. The analysis of investors' risk-adjusted returns shows that their trading experience contributes to better performance on the stock market compared to the investors with lower trading experience. The message of this study is that investors having different educational characteristics trade differently on the stock market and real-life trading experience significantly contributes to investors' performance.

At first sight the findings of this study contradict conclusions presented by Barber and Odean (2000, 2001) who found that too much trading has a negative effect on investors' wealth. More detailed analysis of investors transactions provides an explanation for this apparent conflict. The analysis of investors' transactions reveals that to a certain point, a larger number of trades increases the probability of the performance success. As the number of trades increases over 100 during the observed period, the probability of being successful decreases. Such a finding is consistent with Barber and Odean (2000) who claim that trading too much is unfavourable to investors' wealth, but is also consistent with the findings of Nicolosi et al. (2009) who suggest that trading experience to some extent improves stock market performance as the investors learn from their trading experience.

Controlling for other characteristics such as age, average number of stocks in the portfolio, average portfolio size and average holding period, educational factors, and control variables remain significant. Many of the findings regarding the control variables confirm the results of previous studies indicating that investors on the Tallinn Stock Exchange have similar trading characteristics to the investors in the rest of Europe, Asia or the U.S.A. The analysis of the findings regarding control variables indicate that male investors trade more actively compared to females. This conclusion is in line with the documentation of Barber and Odean (2001), Graham, Harvey, and Huang (2009), Grinblatt and Keloharju (2009) and Hoffmann, Shefrin, and Pennings (2010), who conclude that men trade more than females on the stock market. In addition, control variables indicate that the investors who made more transactions on the stock market held more diversified and larger portfolios. On the other hand, the investors trading more actively on the stock market have a lower average stock holding period. These findings are in line with the conclusions of Graham et al. (2009) and Grinblatt and Keloharju (2009).

The second section provides an overview of previous studies. The third section presents a unique dataset and provides details of the methodology of trading activity and investors' performance measurement. The fourth section offers empirical evidence and the fifth section concludes.

2. Previous studies

This section summarizes how education influences investors' trading decisions and performance on the stock market. Prior research in the field of household finance suggests that education has a significant impact on investors' financial decisions including stock market participation choices, risk-taking behaviour and performance. Guiso, Haliassos, and Jappelli (2003) state that investors' choices to participate on the stock market are strongly influenced by the level of education and wealth. These findings are also supported by Campbell (2006), who concludes that less-educated and less-wealthy

households tend to avoid investing in stocks. He proposes that this kind of behaviour may be reasonable, because less-educated individuals tend to make more investment mistakes. Therefore, it should not be a surprise that financial knowledge and participation on the stock market increases together with the overall education level and household resources as stated by Guiso and Jappelli (2005).

Besides stock market participation decisions, education is an important characteristic explaining investor risk-taking behaviour on the stock market. Haliassos and Bertaut (1995) found that individuals with less than a college degree are less likely to hold risky assets, compared to individuals with at least a college degree. The findings confirmed conclusions by Grable (1998), who provides empirical evidence that the higher an individual's education, the greater the likelihood of the individual having higher risk tolerance. Grable (1998) concludes that education appears to encourage risk taking, because increased level of attained academic training allows individuals to assess risk and benefits more carefully than in the case of someone with less education.

In addition, education is considered a significant factor determining investors' portfolio diversification choices, which is directly linked to the investor risk-taking behaviour on the stock market. Goetzmann and Kumar (2008) analyse under-diversification of investors and find that investors tend to hold portfolios that are highly volatile and consist of stocks that are more highly correlated than one would expect when stocks were chosen randomly. They show that US individual investors hold under-diversified portfolios, whereas the level of under-diversification is greater among younger, low-income, less-educated, and less-sophisticated investors. Anderson (2007) ties individual investor portfolio diversification together by documenting that lower income, poorer, younger and less well-educated investors invest a greater proportion of their wealth in individual stocks, hold more highly concentrated portfolios and have worse trading performance. Based on prior empirical research, education plays a significant role in investors' financial decisions. Hence, it could be presumed that education has a significant impact on investors' trading activity.

As education is considered one key factor explaining investors participation and risk-taking choices, it is important to study whether education also has an influence on investor trading activity on the stock market. One might think that as investing on the stock market is a complex task and during the process investor puts its own money on the table, the investor would analyse its investment decisions in more detail, but in reality the opposite is the case. Griffin and Tversky (1992) demonstrate that when predictability is very low, as can be observed on the stock market, even experts may oversimplify their investment decisions, which lead to poor investment choices. Barber and Odean (2008) find that many investors make various mistakes in their investment decisions when investing on the stock market. Shefrin (2002) reveals the reasons behind irrational and faulty investment decisions by stating that investors tend to oversimplify the situations. Shefrin (2002) claims that heuristic-driven biases and framing effects have an impact on market prices by driving them away from fundamental values.

Regardless investors' irrationality Daniel, Hirshleifer, and Subrahmanyam (1998) and Gervais and Odean (2001) claim that investors do learn from previous mistakes through their private signals and that those mistakes are not systematic. In spite several empirical researches, the results regarding individual learning are mixed. Knetsch and Sinden (1984) and Camerer and Hogarth (1999) argue that learning can take a long period of time and may not be effective in eliminating behavioural biases. Nicolosi et al. (2009) argue that not

only does the laboratory setup fail to accurately capture investor behaviour when significant wealth is at stake, but the subjects also deal with relatively simple signals and tasks, leading to more restricted learning. They state that learning in a trading environment can be more challenging. Still, studies show that real-life trading experience has a significant role in eliminating judgment errors, such as the endowment effect (List, 2003) and the disposition effect (Dhar & Zhu, 2006). In addition, Roth and Erev (1998) and Feng and Seasholes (2005) provide empirical evidence that investor sophistication and trading experience help to reduce certain behavioural biases in financial markets and that individuals' behaviour improves over time. Determining whether education affects investor trading experience in the form of trading activity, would be one important step forward in understanding the investors' financial decision-making process on the stock market.

Discussion whether active trading is beneficial for investors' performance has been initiated by several authors. Feng and Seasholes (2005) and Nicolosi et al. (2009) use the number of transactions as a proxy for investor experience and sophistication and conclude that trading experience contributes to better performance. On the other hand, Grinblatt and Keloharju (2009) and Barber and Odean (2001) use the number of transactions as a proxy for investor overconfidence and find that too much trading has a negative effect on investors' wealth. This empirical documentation contradicts at first sight the findings of this study, but detailed analysis in Section 4.4 suggest, that trading experience to some extent increases stock market performance as investors do benefit from real-life trading experience.

Prior researchers show that education contributes to more rational investment decisions on the stock market. This study addresses how comprehensive educational characteristics influence investors' trading activity and whether investors learn from their trading experience and demonstrate better performance on the stock market. In order to test the learning effect, the study compares investors risk-adjusted returns on the stock market as done by Nicolosi et al. (2009). This study uses a unique dataset from the Estonian Stock Exchange and combines it with the national education dataset.

3. Data and methodology

This study uses a dataset from the Tallinn Stock Exchange, provided by Nasdaq OMX Tallinn. The data cover the period of 9 years starting from 01.01.2004 to 31.12.2012 and includes all transactions made with listed Estonian companies. The period covers transactions for a total of 23 listed companies, which were traded on the Estonian Stock Exchange during that period. Nasdaq OMX Tallinn has a market capitalization of about 1.7 billion euros as of 31.12.2014.

Besides the data from Nasdaq OMX Tallinn, a unique dataset from the Estonian Ministry of Education and Research is used,[1] which includes all high school grades and results of high school final exams. Descriptive statistics about investors educational characteristics together with the number of transactions is presented in Table 1. Combining those unique datasets allows to analyse different individual investor types based on gender, age, portfolio size, the average number of stocks in a portfolio, the average stocks holding period, the level of education, education type and high school exams. This has not been possible for previous studies due to limited data availability.

Table 1. Investor education and trading activity on the stock market.

Independent variables	Number of observations	Number of trades						
				Percentiles				
		Mean	Std. dev.	10th	25th	50th	75th	90th
Mathematics exam bottom quartile	1135	17.52	41.90	2	3	6	15	39
Mathematics exam top quartile	1184	18.39	64.42	2	3	6	16	39
English exam bottom quartile	1297	19.24	44.78	2	2	6	18	42
English exam top quartile	1374	16.38	41.80	2	2	5	14	35
History exam bottom quartile	637	18.16	85.04	2	2	5	14	30
History exam top quartile	666	27.35	200.11	2	2	6	16	39
Mother tongue exam bottom quartile	1602	18.89	66.36	2	2	6	15	35
Mother tongue exam top quartile	1667	18.56	55.31	2	2	6	15	39
Physics exam bottom quartile	209	17.49	32.21	2	2	7	18	42
Physics exam top quartile	220	15.12	23.00	2	3	7	16	38.5
Geography exam bottom quartile	303	9.38	15.55	2	2	4	10	21
Geography exam top quartile	311	13.66	24.54	2	2	5	14	37
Egghead	2510	20.48	117.41	2	2	5	16	39
No egghead	4332	17.60	52.28	2	2	4	14	36
Higher education	8311	20.24	81.09	2	2	6	16	41
High school graduate	2244	14.82	58.07	2	2	5	12	30
Natural sciences degree	1244	21.76	68.89	2	3	7	19	46
No natural sciences degree	9311	18.74	77.79	2	2	5	14	37
Degree in medicine	169	13.51	42.25	1	2	4	10	32
No degree in medicine	10386	19.18	77.23	2	2	5	15	38
All investors with educational data	10555	19.10	76.80	2	2	5	15	38
Male	19189	22.77	103.78	2	2	5	16	43
Female	8627	10.80	82.88	1	2	3	8	19
Lowest trading group	3393	1.00	0.00	1	1	1	1	1
Second trading group	12346	2.69	0.79	2	2	2	3	4
Third trading group	9511	8.23	2.76	5	6	8	10	13
Highest trading group	8589	141.21	2254.22	17	21	33	66	152

Source: Author's calculations.

Note: The table reports independent variables descriptive statistics by the following educational categories: national high school exam result groups, level and type of education. In addition, the table reports demographic and group allocations based on investor trading activity. The table reports the number of observations, mean, standard deviation and percentile allocation of average trades based on investors' educational characteristics.

The total number of different investors who made at least one purchase during the sample period is 33,839, of which 27,816 are individual investors. Out of those investors, official educational data have been obtained for 10,555 investors and that forms the main sample for the analysis. Although the stock market data for the whole population have been obtained, it is possible to use educational data of only those investors whose data are in the educational register, which reduces the sample of the investors.

For all investors the transaction date, price and the specific stock has been obtained. As investors' stock purchasing prices before January 2004 have not been obtained, the positions opened before that are not used for any of the calculations. Prices are adjusted for stock splits and dividends. Investors' trading activity is measured as the number of transactions executed by the investor as suggested by Feng and Seasholes (2005) and Nicolosi et al. (2009). Nicolosi et al. (2009) state that an alternative measure for trading activity is trade turnover, but the number of trades is a straightforward measure for trading intensity. Hence, this study uses the number of transactions as a measure for investors' trading activity.

The dependent variable is a categorical variable based on the number of transactions made by an investor during the period of 2004 until 2012. The dependent variable is

divided into quartiles. Investors allocated to the lowest trading activity group made only one transaction during the observed period. For the second group, the number of trades varies between two to four trades. In the third group, investors made between 5 and 14 trades and the investors belonging to the highest trading group made 15 or more trades. The allocation to quartiles has been made, so that the number of investors in each group would be similar. The first group has a smaller number of investors compared to other quartiles due to the reason that the number of investors who made only one trade is smaller.

For empirical model control variables, this study uses gender, age, portfolio size, portfolio diversification and the average stock holding period based on the documentation of Feng and Seasholes (2005) and Grinblatt and Keloharju (2009). Most of the independent variables are binary. This study uses probability models to analyse the effect of educational characteristics on investor trading activity. Table 1 indicates that the mean and standard deviations for the number of trades are rather large. Therefore, the dependent variable is categorized to quartiles to eliminate the effect of outliers. For this kind of data analysis, the ordered logit regression model has been used by Coval and Shumway (2005), Greene (1997), Gelman and Hill (2007) and van Dijk and Pellenbarg (2000). For robustness analysis, the study uses logit regression models to study the effect of educational and other characteristics on different trading groups separately.

The study analyses different exam results in a single and in a multivariable model, because each high school graduate has to take three to five state exams. The exam results are divided into quartiles to analyse the effect of the top and bottom exam results on trading activity. A high school graduate has to take mandatory exams such as mathematics, mother tongue and English or German, while other exams are optional. When more than one exam is included in the regression model, multicollinearity starts to affect the results. It can be assumed that students who are good at certain subject are also successful at other subjects, thus the multicollinearity. To solve the problem, a new variable called 'egghead'[2] has been constructed.

The traders in the sample are relatively young and most of the investors belong to the Y generation, because the national exams are taken around the age of 18 and the dataset obtained from the Estonian Ministry of Education and Research starts from 1997. The average age of the investors in the sample is 32.6 years. Still, the sample is in line with the overall Estonian stock market as an average Estonian investor is also relatively young due to the short history of its capital markets (Talpsepp, 2011). The age distribution of the sample is presented in Figure 1.

The study uses aggregate data for the average return for investors during the observed period. As investors can also trade foreign stocks and change the amount invested, which has an effect on performance, the portfolio return is calculated as an annual money-weighted return. Each transaction has been adjusted for transaction costs in the amount of five euros plus 0.1% of the transaction amount. Markowitz (1991) and Modigliani and Modigliani (1997) state that to have a true picture of the investors' performance, the risk, which is associated with a particular investment, should be taken into account. Therefore, each individual's risk-adjusted returns are calculated, because some investors might intentionally take higher risks in order to achieve higher returns. Modigliani and Modigliani (1997) choose standard deviation as a measure of risk.

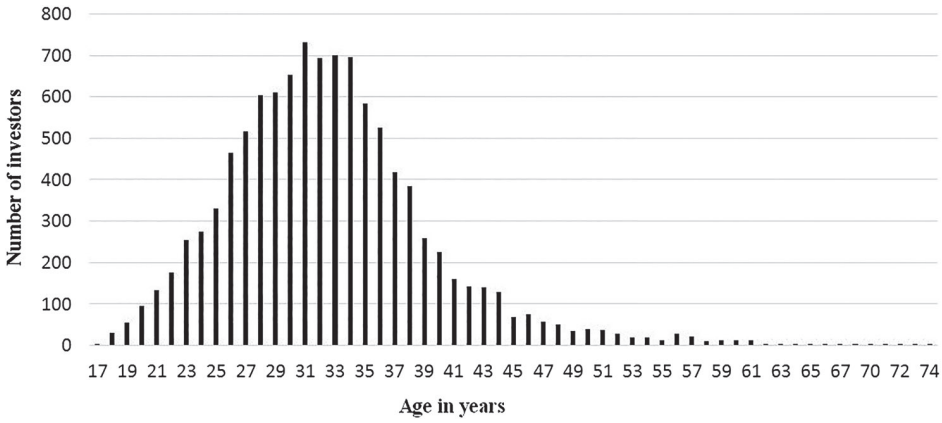

Figure 1. Investors age distribution. Source: Nasdaq OMX Tallinn dataset, author's calculations.

4. Empirical results

This section presents the results of how detailed educational characteristics affect investors' trading activity on the stock market. This study offers evidence how high school national exam results, a university degree and the type of education affect investors' trading decisions. In addition, the study analyses other factors such as age, the average number of stocks in the portfolio, the average portfolio size and the average holding period. The section ends with the analysis how trading experience in the form of the number of trades influences investors' risk-adjusted performance on the stock market.

4.1. Do top performers in high school national exams trade more?

This part of the study uses an ordered logit regression model to test the hypothesis whether investors with better high school exam results trade more actively on the stock market. The study runs a single-ordered logit regression model to study the isolated effects of educational variables on investors' trading activity and then includes a number of control variables such as age, gender, portfolio size as a proxy for wealth, portfolio diversification and the average holding period in the regression. The study analyses regression models with control variables individually and does not combine them in one model due to multicollinearity between educational characteristics.

The paper analyses high school exam results in a simple ordered logit regression and then together with the control variables. The statistical significance of the control variable coefficients in the regression results does not change for different regression model setups. The results of all regressions are available upon request. The paper reports the most relevant national exams and university specialties determined on the basis of the exam participation rate. Table 2 shows that statistically significant high school exam results for simple and multivariable regression are only geography exam bottom quartile results and egghead group results. Neither mathematics, physics, mother tongue, English or history exam results are statistically significant for both regressions.

For further interpretation, the paper uses only those results which are statistically significant for both regressions. Table 2 presents the results in odds ratio to simplify

Table 2. An ordered logit regression model for the investors' trading activity and educational characteristics.

	Individual variables for number of trades		High school exam results and control variables		Educational level and control variables		Education type and control variables	
	Odds ratio	*z*-value	Odds ratio	*z*-value	Odds ratio	*z*-value	Odds ratio	*z*-value
Mathematics exam top quartile	1.06	0.95	0.97	−0.34				
Mathematics exam bottom quartile	0.97	−0.53	1.03	0.42				
Physics exam top quartile	0.98	−0.17	0.97	−0.17				
Physics exam bottom quartile	0.86	−1.01	1.04	0.21				
Mother tongue exam top quartile	1.04	0.76	1.02	0.26				
Mother tongue exam bottom quartile	0.97	−0.63	0.99	−0.02				
English exam top quartile	0.97	−0.55	0.93	−0.94				
English exam bottom quartile	1.19***	2.99	1.11	1.44				
History exam top quartile	1.08	0.90	1.15	1.35				
History exam bottom quartile	0.80***	−2.75	0.87	−1.31				
Geography exam top quartile	1.18	1.35	1.19	1.11				
Geography exam bottom quartile	0.76**	−2.29	0.65***	−2.75				
Eggheads (exam high performers)	1.08**	2.07	1.08**	2.10				
Higher education	1.31***	6.26			1.18***	2.83		
Master's or doctoral degree	1.01	0.18			1.15	1.01		
Bachelor or equivalent degree	1.22***	5.54			1.07	1.53		
High school graduate	0.76***	−6.26			0.85***	−2.83		
Natural sciences degree	1.32***	5.04			1.16**	2.11		
Humanities degree	0.83**	−2.27			1.06	0.49		
Social science degree	1.11***	2.95			1.00	−0.01		
Degree in economics	1.05	1.27					0.90**	−2.00
Degree in public administration	1.05	0.38					1.07	0.41
Degree in finance	0.91	−0.79					1.15	0.86
Degree in information technology	1.23***	2.91					1.06	0.69
Degree in mathematics or statistics	1.35	0.97					1.32	0.73
Degree in physics or chemistry or biology	1.18	1.03					1.23	1.02
Degree in law	1.09	1.06					1.06	0.55
Degree in medicine	0.67***	−2.85					0.68**	−2.05
Degree in psychology	0.68*	−1.86					1.08	0.30
Male			2.11***	7.98	1.89***	11.57	1.86***	11.26
Birth year			1.01	0.66	1.00	0.94	1.00	−0.40
Average stocks in portfolio			4.19***	28.40	3.97***	41.94	3.98***	41.97
Average portfolio size			1.01***	14.09	1.01***	21.65	1.01***	21.77
Average holding period			0.99***	−15.15	0.99***	−22.58	0.99***	−22.5
Log likelihood			−3185		−7075		−7077	
Pseudo R^2			0.25		0.26		0.26	

Source: Author's calculations.

Note: Table 2 reports coefficients and *z*-values from an ordered logit regression with robust standard errors in which the categorical dependent variable takes the value 0–3, depending on the investors' number of transactions. The first column presents independent dummy variables. Other columns present multiple regression results. The second, third and fourth column regressions are run individually together with control variables, because of multicollinearity. Table 2 presents control variables coefficients for mathematics exam results in the second column, in the third column for higher education and in the fourth column for investors holding a degree in economics. The statistical significance of other regression control variables coefficients does not differ and are available upon request. The table presents odds ratios to simplify interpretation. If odds ratio > 1, it means there is an increased probability of belonging to a particular group because of the factor.

*Coefficients statistically significant at the 10%, level.

**Coefficients statistically significant at the 5% level.

***Coefficients statistically significant at the 1% level.

interpretation. The odds ratio above one indicates increased probability of belonging to a particular group, because of the factor and vice versa. The results in Table 2 for single and multivariable ordered logit regression show that geography exam bottom quartile results are statistically significant at the 1% level and the egghead category is statistically significant at the 5% level. The odds ratio presented in Table 2 for the geography exam bottom quartile is for both ordered logit regressions below one (single-ordered logit regression odds ratio is 0.76 and for the control variables 0.65), indicating that investors belonging to the geography exam bottom group trade less compared to the investors with no such an educational characteristic.

The odds ratio presented in Table 2 for the egghead category is for both ordered logit regressions 1.08, indicating that investors belonging to the egghead category trade more actively compared to the investors with no such an educational characteristic. The reason might be in a larger population, which makes this group relevant for trading activity. Neither mathematics, English, physics, mother tongue nor history exam top and bottom performers are alone statistically significant. The study obtained similar results when logit regression models were used for the purpose of robustness check.

The marginal effect analysis presented in Table 3 indicates that the probability of belonging among the low trading activity investors' group increases by 2.51% for poor performers in geography high school exam. The investors belonging to the low performing group in geography exams made on average 9.38 trades compared to investors' population average of 19.1 trades. The results of Table 3 show that the probability of belonging to the most active traders group increases by 1.48% for the egghead category. The investors belonging to the egghead group made on average 20.48 trades compared to 17.4 trades made by the investors not belonging to this category. Consequently, the study finds confirmation to the hypothesis that the investors having top results in national exams trade more actively on the stock market. The investors risk-adjusted performance is analysed in section 4.4.

Table 3. Marginal effect analysis for the investor trading activity quartiles.

	Quartile I		Quartile II		Quartile III		Quartile IV	
	Coef.	*z*-values	Coef.	*z*-values	Coef.	*z*-values	Coef.	*z*-values
Marginal effect for high school exam results								
Geography exam bottom quartile	2.51%**	2.15	4.37%**	2.36	−2.58%**	−2.13	−4.29%**	−2.38
Eggheads (exam high performers)	−0.68%***	−2.13	−1.23%**	−2.05	0.43%	0.03	1.48%**	2.04
Marginal effect for education level								
Higher education	−2.04%***	−5.80	−4.69%***	−6.39	1.78%***	5.45	4.95%***	6.52
High school graduate	2.04%***	5.80	4.69%***	6.39	−1.78%***	−5.45	−4.95%***	−6.52
Natural sciences degree	−1.79%***	−5.46	−4.95%***	−5.00	1.21%***	6.78	5.53%***	4.82
Marginal effect for education type and control variables								
Degree in medicine	3.30%**	2.45	6.58%***	3.12	−3.06%**	−2.33	−6.82%***	−3.19

Source: Author's calculations.

Note: Table 3 reports the marginal effect and *z*-values from an ordered logit regression marginal analysis for the discrete change in a dummy variable from 0 to 1. Category I quartile represents the lowest and category IV quartile the highest trading activity investors group.

*Coefficients significant at the 10% level.

**Coefficients significant at the 5% level.

***Coefficients significant at the 1% level.

Table 2 reports that on an individual level national high school exam results (except geography exam) are statistically not significant. This raises the question why mathematics high school exam results, which one would consider as one type of cognitive ability, are not significant and result in geography exams are significant for trading activity. The reason might hide in the specific type of cognitive abilities. One possible interpretation could be that individuals performing well in geography exams may have an increased and open curiosity for learning about the world around us. Just the opposite, investors demonstrating poor results in geography exam may have decreased interest in learning how the world works. Those findings relate to documentation of Borghans, Duckworth, Heckman, and Weel (2008) who state that both cognitive abilities and personality traits predict a variety of social and economic outcomes. Dohmen et al. (2011) provide further empirical evidence that cognitive abilities are closely related to risk aversion and impatience, which are significant factors influencing investors' trading decisions.

The results in Table 2 reveal that investors performing poorly in geography high school exams are the only statistically significant investors group in high school exam results which affects trading decisions. Further and deeper analysis of university specialty choices for geography exam low performers reveals that this group of investors chooses with high probability not to continue their studies at university (Vaarmets, 2015). This finding is in line with the conclusion that investors with no academic degree are more likely to trade less actively on the stock market. As for this study, it is not possible to acquire more detailed information regarding the geography exam structure and student answers, there is also a chance that the result is just a random outcome.

4.2. Do higher educated investors trade more?

This part of the study tests the hypothesis that investors holding a university degree trade more actively on the stock market compared to investors without a university degree. In addition, the study provides empirical evidence how the education type affects trading activity on the stock market.

The study uses the same control variables in ordered logit regressions for the university degree and the level of education as in previous analysis of the national exams. All available data of university degree types held by investors have been collected and grouped into different categories according to the names of university programs. The results for the level of education show that the investors with higher education have the odds ratio above one indicating that the investors with a university degree trade more actively on the stock market compared to the investors with no academic university degree. The coefficient is statistically significant and the odds ratio for the investors with higher education for a single-ordered logit regression is 1.31 and for an ordered logit regression with control variables 1.18. The analysis of the high school graduates, bachelor's and master's or doctoral degree holders separately reveals that the investors having only high school graduate diploma have the odds ratio below one indicating that investors with such educational characteristics trade less stocks. The coefficient is statistically significant and the odds ratio for the investors holding only a high school graduate diploma for a single regression is 0.76 and for a regression with control variables 0.85. The ordered logit regression coefficients for bachelor's and master's or doctoral degree holders are above one, indicating that the investors holding those degrees trade more actively on the

stock market. Still, as those coefficients are statistically not significant for all regressions, the study cannot draw a conclusion regarding bachelor's and master's or doctoral degrees separately.

The results of marginal analysis presented in Table 3 show that the probability of an investor belonging to the lowest trading group increases by 2.04% if the investor holds no academic degree. In case the investor has higher education, the probability to belong to the highest trading group increases by 4.95%. Investors with an academic degree made on average 20.24 trades compared to 14.82 trades by investors with no academic degree. Consequently, the study confirms the hypothesis that investors holding a university degree trade more actively on the stock market compared to investors with no university degree.

The study analyses the results for the education level by the type of science and finds that the investors holding degree in natural sciences have the odds ratio above one. It shows that the investors with such a university degree trade more on the stock market compared to the investors with no such an educational characteristic. The coefficient is statistically significant and the odds ratio for investors holding a degree in natural sciences for a single regression is 1.32 and for a regression with control variables 1.16. The marginal analysis results reveal that the probability of an investor belonging to the highest trading investors group increases by 5.53% if the investor holds a natural science degree. The investors with a degree in natural science made on average 21.76 trades compared to 18.74 trades by the investors with no such a degree. Interestingly natural science specialties alone are statistically not significant and therefore the study cannot draw conclusions regarding those specialities on an individual level. Still, the ordered logit regression coefficients for biology, chemistry, physics and mathematics specialty are above one, indicating that investors holding this specialty degree are more likely to trade actively on the stock market. Neither social sciences nor humanities degrees are statistically significant for investors' trading activity. The study used a logit regression for robustness check purposes and obtained similar results.

In addition, the study analyses university specialties. The odds ratio presented in Table 2 for medicine degree holders for both ordered logit regressions is below one (the single odds ratio of 0.67 and the odds ratio with control variables of 0.68), indicating that the investors holding this degree tend to make less transactions on the stock market. The marginal effect analysis in Table 3 indicates that the probability of belonging to the group of lowest trading investors increases by 3.30% if the investor holds a degree in medicine. The investors with a medicine degree made on average 13.51 trades compared to 19.18 trades in the case of investors not belonging to this category. As it was is not possible to inquire more detailed information regarding medicine students and the medicine students' population is rather small in the total sample, there is also a chance that the result is just a random outcome. Neither economics, law, public administration, physics, medicine, information technology, finance or psychology seem to be statistically significant.

One possible reason for more active trading among the investors with higher education and a degree in natural sciences might be connected with their higher intellectual abilities which are enhanced while they are their university students. Higher intellectual abilities come with the potential of analysing their trades and learning from this experience. The statement that a higher level of education helps investors to make more rational investment decisions is supported by Grinblatt, Keloharju, and Linnainmaa (2012). Detailed analysis regarding the investors ability to learn from their trading experience and to improve their risk-adjusted performance is presented in Section 4.4.

The results in Table 2 show that holders of degrees in natural are likely to execute more trades on the stock market compared to investors with no such a degree. The analysis of high school exam results does not show that investors with good results in natural science exams such as mathematics, physics, biology or chemistry has a statistically significant effect on trading activity. The study analyses investors university specialty choices and finds that investors with good results in natural science exams like as well as mathematics, physics or biology do choose to continue their university studies with higher probability in natural sciences, but the strongest effect on the decision to obtain a university degree in natural sciences, is noted in case of geography exam top performers. The results are statistically significant and the coefficient is much higher than for the mathematics, physics or biology high school top performers. Detailed analysis of investors' educational choices in the same dataset is presented by Vaarmets (2015).

4.3. Other factors influencing investor trading activity

In addition to educational characteristics, this study analyses a number of other factors, which influence investors' trading activity. When including continuous control variables such as the birth year, the average number of stocks in the portfolio, the average portfolio size and the average holding period, educational factors and control variables remain significant.

This study analyses demographic variables such as the birth year and gender and finds that only the latter is statistically significant. The odds ratio for male investors presented in Table 2 indicates that male investors are more active in trading stocks compared to female investors. This conclusion is in line with the finding of Barber and Odean (2001) who find that men trade 45% more than women.

In addition, the level of wealth seems to be an important factor for trading activity. The average portfolio size was used as a proxy for wealth. Results presented in Table 2 show that a higher portfolio size increases the average number of stocks traded on the stock market as the control variable coefficient is above one and statistically significant. This finding is in line with the findings of Graham et al. (2009) who conclude that wealthier investors are more likely to perceive themselves as competent and therefore trade also more actively on the stock market. In addition, this paper finds that investors who trade more actively hold more diversified portfolios, but hold their stocks in the portfolio for a shorter period of time. Those findings are in line with the conclusions of Grinblatt and Keloharju (2009).

The findings that investors who trade more actively hold more diversified portfolios and have a higher portfolio size is expected. In order to draw a final conclusion how portfolio diversification and portfolio size influence trading activity a ratio analysis should be performed. As the findings regarding control variables are not the main focus of the paper the ratio analysis would be the focus of another study.

4.4. Trading activity and investor risk-adjusted returns

Prior studies suggest that besides other factors education and trading experience help investors to achieve better performance on the stock market. Grinblatt et al. (2012) provide empirical evidence that investors with higher IQ achieve better performance. More detailed empirical analysis has been done by Liivamägi et al. (2014) who used the same dataset and provided empirical evidence that the level and type of education

affect performance on the stock market. The focus of this study is to analyse investors' real-life trading experience and the relationship to risk-adjusted performance. For this kind of analysis, Feng and Seasholes (2005) and Nicolosi et al. (2009) suggest using the total number of transactions as a measure of investor trading experience in the form of trading activity. To test whether investors who trade more stocks learn from their trading experience, the study analyses their risk-adjusted performance.

Table 4 reports coefficients and *t*-values from a regression where the independent variable is the number of trades and the dependent variable is investors' risk-adjusted return. The results reported in Table 4 are statistically significant at the 5% level. The coefficients reported in Table 4 indicate that the third and fourth trading activity groups, which are the groups with the highest number of trades, have a positive and statistically significant influence on the investors' risk-adjusted performance. The opposite is true for the second trading group with low trading activity as the negative coefficient indicates an

Table 4. Investor risk-adjusted performance and trading activity on the stock market.

		Risk-adjusted returns for trading activity groups				
		Percentiles				
	Number of observations	25th	50th	75th	Coefficient	*t*-value
I group (low trading activity)						
Full period 2004–2012	1325	−6%	1%	16%	0.10**	2.08
Period 2004–2007	334	16%	40%	92%		
Period 2007–2009	401	−52%	−44%	−29%		
Period 2009–2012	516	−3%	8%	21%		
II group						
Full period 2004–2012	8896	−10%	−3%	5%	−0.76***	−32.25
Period 2004–2007	5553	11%	12%	28%		
Period 2007–2009	2516	−51%	−42%	−34%		
Period 2009–2012	1830	−5%	7%	20%		
III group						
Full period 2004–2012	8257	−6%	2%	15%	0.13***	5.49
Period 2004–2007	4796	12%	32%	78%		
Period 2007–2009	3705	−51%	−42%	−30%		
Period 2009–2012	3140	−3%	8%	21%		
IV group (high trading activity)						
Full period 2004–2012	8251	−4%	6%	20%	0.64***	26.71
Period 2004–2007	4673	25%	50%	102%		
Period 2007–2009	5239	−50%	−40%	−24%		
Period 2009–2012	5238	2%	12%	26%		
All investors						
Full period 2004–2012	26729	−7%	1%	14%	0.30***	2.99
Period 2004–2007	15408	12%	27%	72%		
Period 2007–2009	11943	−51%	−42%	−28%		
Period 2009–2012	10885	0%	10%	24%		

Source: Author's calculations.

Note: Table 4 reports investors' portfolio risk-adjusted performance based on investors' trading activity on the stock market. The I group consists of investors with the lowest trading activity and the IV group consists of investors, who made the most trades. The table reports investors' risk-adjusted performance during business cycles. In the first column performance is reported for the full period; in the second column for the bull market period from 1 January 2004 to 5 February 2007; in the third column for the bear market period from 6 February 2007 to 9 March 2009; in the fourth column for the bull market period from 10 March 2009 to 31 December 2012. The table reports the number of observations, percentile risk-adjusted returns for investor groups, regression coefficients and *t*-values. The table reports coefficients and *t*-values from a regression where the independent variable is the number of trades and the dependent variable is investors' risk-adjusted return.

*Coefficients significant at the 10% level.

**Coefficients significant at the 5% level.

***Coefficients significant at the 1% level.

unfavourable influence on the risk-adjusted performance. The first group with the lowest trading activity has a positive coefficient indicating a favourable effect on the risk-adjusted performance, but the relationship to risk-adjusted performance is weaker than for the two groups with the highest trading activity. The regression coefficient presented for the whole investor population in Table 4 is positive and statistically significant at the 1% level. The results of regression analysis confirm the hypothesis that more executed trades, which is a proxy for investors' experience, have a positive effect on investors' risk-adjusted performance.

Table 4 presents performance measures for different trading groups of investors throughout the business cycles. The results for the full period from 2004 to 2012 indicate that investors with more trading experience achieve higher risk-adjusted returns. The risk-adjusted return for the investors in the 50th percentile and those who belong to the group of lowest trading activity is 1%. The risk-adjusted return for the investors in the 50th percentile and those who belong to the medium activity groups and high trading activity group are, respectively, −3%, 2% and 6%. In Table 4 the results for average risk-adjusted performance indicate that risk-adjusted performance increases group by group if the number of trades increases.

It is important to point out the finding by Barber and Odean (2000) and Barber and Odean (2001) who found that too much trading has a negative effect on investors' wealth. At first this finding contradicts conclusions of this study, but more detailed analysis provides an explanation of this conflict. By dividing investors into 10 categories according to the number of transactions reveals that to a certain point, a larger number of trades increases the performance success probability, but executing more than 100 transactions during the period reduces the probability of being successful. Such a finding is consistent with Barber and Odean (2000) who claim that trading too much is unfavourable for investors' wealth, but is also consistent with the findings of Nicolosi et al. (2009) who suggest that trading experience to some extent increases stock market performance as investors do learn from their experience.

5. Conclusion

Previous studies provide empirical evidence that trading experience helps eliminate judgement errors, such as the endowment effect and the disposition effect. This paper provides the first empirical documentation of comprehensive educational characteristics that influence investor trading experience in the form of trading activity on the stock market. This study extends documentation of previous studies and offers detailed empirical evidence to confirm the hypothesis that investors with academic education or those who demonstrate top results in national exams trade more actively on the stock market. In addition, the study finds that investors holding a degree in natural sciences trade more actively on the stock market compared to investors with no such a degree. The opposite is true for investors with no academic degree and for investors with low results in geography national exams as they execute a lower number of trades. In addition, the study finds that investors holding a degree in medicine trade less actively on the stock market. Other university degrees do not seem to influence investor trading activity. The regression analysis regarding investors' risk-adjusted returns reveals that trading experience helps

investors to achieve better performance on the stock market compared to investors with lower trading experience.

In addition, many of the findings confirm the results of previous studies including that male investors trade more actively compared to female. In addition, the study concludes that investors who made more transactions on the stock market hold more diversified and larger portfolios. Additionally, the study finds that investors trading more actively hold stocks in their portfolio for a shorter period of time.

Having provided evidence that investors with an academic degree and better results in national exams trade more on the stock market, further studies could address the research question how their trading activity has evolved and changed during business cycles.

Notes

1. The stock market and educational data sets were combined by using national identity codes. Data used for analysis are anonymized.
2. The dummy variable egghead has been generated to represent a student who has the average national high school exam result over 70% of the maximum exam score. As every student has to take at least three national high school exams the egghead dummy represents a student with the average of those exam results of over 70%.

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No potential conflict of interest was reported by the author.

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PAPER III

INVESTOR EDUCATION AND IPO PARTICUIPATION

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Investor Education and IPO Participation

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ABSTRACT: This study analyses how the educational characteristics of investors affect their participation in initial public offerings on the stock market. We use a unique dataset from the Tallinn stock exchange that combines the stock market transactions of a full business cycle from 2004 to 2012 with an official educational dataset. Having controlled for gender, age, wealth and investor trading behaviour, we find empirical evidence that investors with better high school exam results in mathematics and high school leavers without an academic degree are less likely to participate in an IPO. The opposite is true for investors who have higher education, a bachelor's degree or a degree in the social sciences, economics or public administration, who are all more likely to participate in an IPO. We find that the long-term returns of IPO stocks underperform benchmark index returns.

KEYWORDS: IPO, investor, education, stock market, performance

1. Introduction

Education has a significant influence on the financial decisions that investors make and on their stock market behaviour. Guiso, Haliassos, and Jappelli (2003) argue that the choice by investors of whether to participate in the stock market is strongly influenced by their level of

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education. Campbell (2006) finds that better educated investors participate more actively in the stock market as they tend to make more rational investment decisions than investors with a lower level of education do. Education not only affects the decision to participate in a stock market but is also considered a key element in explaining investors' risk-taking behaviour. Grable (1998) shows that education appears to encourage risk taking and proposes this might be because a higher level of academic training allows individuals to assess risk and benefits more carefully and so people with more education have higher risk tolerance. He argues that better understanding of the concept of risk and return helps investors to diversify their risks so that they do not take unnecessary risks for which they are not compensated. Goetzmann and Kumar (2008) find that investors who are younger, have lower income, are less educated, or are less sophisticated tend to hold portfolios that are highly volatile and consist of stocks that are more highly correlated than would be expected if the stocks were chosen randomly. Anderson (2007) adds to this by stating that less educated investors invest a greater proportion of their wealth in individual stocks, hold more concentrated portfolios, trade more and have worse trading performance.

Education is considered a significant characteristic in explaining how investors participate in a stock market and the financial decisions they make. However, there is no answer to the research question of how detailed educational characteristics can influence the participation of investors in initial public offerings. Kaustia and Knüpfer (2008) argue that investors learn from their past experience when they participate in IPOs. They provide evidence suggesting that individual investors are more likely to participate in IPOs if they have had good returns from past IPOs, meaning that successful IPOs encourage investors to participate more in IPOs while unsuccessful ones discourage them. Keloharju (1993) and Ritter (1991) suggest though that participating in IPOs may not be a smart choice as IPO stocks tend to perform poorly compared to a market benchmark index in the long run. Ritter

(1991) and Hirshleifer (2001) propose a behavioural explanation for the poor performance subsequent to equity offerings, arguing that stock prices periodically diverge from fundamental values, and underwriters take advantage of overpricing by selling stock to overly optimistic investors.

Our aim is to identify the types of investor that are more likely to participate in an IPO. As Goetzmann and Kumar (2008) and Hong, Kubik, and Stein (2004) state that investors with a higher level of education are more likely to participate in the stock market, we set a hypothesis that investors with good results in national state administrated high school exams and investors with a higher level of education are also more likely to participate in an IPO. We also study how the type of education affects participation in IPOs. Liivamägi, Vaarmets, and Talpsepp (2014) find that the level and type of education have an influence on their investment decisions and performance in the stock market. Christiansen, Joensen, and Rangvid (2008) propose that financial decisions are influenced by the type of education and they show that people who have a university degree in economics are more likely to hold stocks. Hence we hypothesise that investors with a university degree in economics are also more likely to participate in an IPO.

The main contribution of the paper is the first empirical documentation of the comprehensive educational characteristics which influence investor participation in IPOs in the stock market. In this paper we extend the documentation of previous studies and offer detailed empirical evidence that investors with better high school exam results in mathematics and high school leavers without an academic degree are less likely to participate in IPOs. Investors who have higher education, a bachelor's degree or a degree in social sciences, economics or public administration are more likely to participate in an IPO. Analysing the risk-adjusted returns for investors reveals that investors who participate in the IPOs achieve lower risk-adjusted returns from the stock market than investors who do not participate in IPOs. This finding is in

line with the documentation of Keloharju (1993) and Schultz (2003), who show that investors who participate in IPOs demonstrate poor performance results in the long term.

Our other findings suggest that investors with a higher number of transactions and investors who hold more stocks in their portfolio are more likely to participate in IPOs. Additionally we note that investors with a higher portfolio turnover rate are also more likely to participate in IPOs. Birth year has a negative influence on IPO participation, indicating that IPO participation decreases as age rises. Age could be seen as a proxy for investor experience, and the results indicate that investors with more experience are more reluctant to participate in an IPO as they might have had negative experiences with prior IPOs. This finding is in line with the conclusion of Kaustia and Knüpfer (2008), who argue that investors learn from their past experience when participating in IPOs. Other demographic and trading characteristics seem to be irrelevant for the choice about participation in an IPO.

The second section gives an overview of previous studies. The third section offers some insight into the unique dataset and gives details on the methodology used to measure IPO participation and investors' performance. The fourth section offers empirical evidence, results and robustness tests, and the fifth section concludes.

2. Previous studies

This section summarises the literature on investor education and IPO participation choices. Education plays a crucial role in the financial decisions that individuals make and their choices about stock market participation. Guiso and Jappelli (2005) provide empirical evidence that education in economics increases financial awareness. Bernheim and Garrett (2003) conclude that financial education at work significantly increases the probability that people receiving it will save in general, and that households who were exposed to courses in finance at high school have higher savings rates than others. The same conclusion is drawn by Bayer, Bernheim and Scholz (2009), who show that financial education has a positive

effect on the participation of individuals and on their contributions to voluntary savings plans. Guiso, Haliassos, and Jappelli (2003) state that whether investors choose to participate in the stock market is strongly influenced by their level of education and wealth. These findings are also supported by Campbell (2006), who concludes that less educated and less wealthy households tend to avoid investing in stocks. He also proposes that such behaviour may be reasonable, because less educated and less wealthy people also tend to make more investment mistakes. Therefore it should not be a surprise that financial knowledge and participation in the stock market increase together with the overall level of education and household resources, as stated by Guiso and Jappelli (2005).

Education not only affects decisions on participation in the stock market, but is also an important characteristic for explaining the risk-taking behaviour of investors in the stock market. Grable (1998) provides empirical evidence that the level of education is a significant factor in the risk tolerance of investors in the stock market. He found that the more education an individual has, the greater the likelihood that they will have higher risk tolerance. The findings confirmed the conclusions of Haliassos and Bertaut (1995), who found that people who had less than a college degree were less likely to hold risky assets than people who had at least a college degree. Grable (1998) concludes that education appears to encourage risk taking, because an increased level of academic training equips people to assess risk and benefits more carefully than someone with less education can. These findings are supported by MacCrimmon and Wehrung (1986).

Investor education is also considered a significant factor in explaining the portfolio diversification choices of investors, which are directly linked to their risk-taking behaviour in the stock market. Goetzmann and Kumar (2008) analyse the under-diversification of investors and find that investors tend to hold portfolios that are highly volatile and consist of stocks that are more highly correlated than would be expected if stocks were chosen

randomly. They show that individual investors in the US hold under-diversified portfolios, and the level of under-diversification is greater among younger, low-income, less educated, and less sophisticated investors. Anderson (2007) ties individual investor portfolio diversification together by documenting that lower-income, poorer, younger, and less educated investors invest a greater proportion of their wealth in individual stocks, hold more concentrated portfolios, trade more, and have worse trading performance. He concludes that investors fail to take advantage of the benefits of diversification.

Prior studies show education to be a key characteristic for explaining the participation of investors in the stock market and the financial decisions they take. However there is no answer to the question of how detailed educational characteristics can influence the participation of investors in initial public offerings. Earlier studies suggest that the decision by an investor to participate in an IPO is influenced by that individual's past experience. Chiang et al. (2011) examine the relationship between an investor's past returns from previous IPO auctions and their inclination to participate in a future IPO auction. They find that individual investors tend to bid in future IPOs if they received high returns in the past and tend to stop bidding if their past returns were poor. In contrast, they claim that the decisions by institutional investors about whether to bid are much less affected by their past returns. This viewpoint is shared by Kaustia and Knüpfer (2008), who claim that investors learn from their past experience of IPO participation. They provide evidence suggesting that individual investors are more likely to participate in IPOs after they have had good returns from earlier IPOs. This shows that IPO investment occurs in response to experience.

IPO events gain the attention of investors, but it is not considered to be a smart choice to participate in IPOs. Studies by several researchers show stocks from IPOs tend to perform poorly compared to market benchmark indexes. The poor long-term performance of IPO stocks has also been documented by Arosio, Giudici, and Paleari (2001), who find a

significant negative correlation between long-run relative performance and initial flipping, suggesting that some investors possess superior information on IPOs. Baker and Wurgler (2000), Ritter (1991) and Hirshleifer (2001) offer a behavioural explanation for poor performance subsequent to equity offerings. They suggest that stock prices periodically diverge from fundamental values, and that IPO issuers take advantage of overpricing by selling stock to overly optimistic investors. They argue that the equity share sometimes predicts significantly negative market returns, suggesting inefficiency, and that firms time the market component of their returns when issuing securities. Ljungqvist, Nanda and Singh (2006) add to this by claiming that under-pricing and long-run underperformance emerge as underwriters attempt to maximise profits from the sale of equity at the expense of the optimistic investors. Schultz (2003) concludes that underperformance is very likely to be observed ex-post in an efficient market. The assumption is that more firms issue equity at higher stock prices even though they cannot predict future returns.

Despite the poor long-term performance of IPOs, investors are still optimistic about IPO performance, which might be caused by the relatively good short-term returns from IPOs. Derrien (2005) finds that IPOs can be overpriced and still exhibit a positive initial return. He suggests that large demand from individual investors leads to high IPO prices, large initial returns and poor long-run performance. A similar conclusion is drawn by Arosio, Giudici, and Paleari (2001), who find that the short-term performance of IPOs exceeds market benchmark indexes, but the long-term performance is worse than that of market benchmark indexes.

Prior research suggests that sentiment plays a crucial role in how investors behave in IPOs. Cornelli, Goldreich and Ljungqvist (2006) state that when small investors are excessively optimistic, they are willing to pay a price above the fundamental value, resulting in a high aftermarket price. Derrien (2005) concludes that demand from individual investors

is positively related to market conditions. Brown and Cliff (2004) find that sentiment levels and changes are strongly correlated with contemporaneous market returns, but sentiment has little predictive power for near-term future stock returns. Market timing is important for IPOs and this is also known by insiders, who accordingly launch their IPOs when market conditions are favourable. Brau and Fawcett (2006) find in their study that CFOs base IPO timing on overall market conditions and are well informed about expected under-pricing. As market participants are aware of IPO under-pricing, Ritter and Welch (2002) argue that IPO under-pricing and long-run performance may be explained by behavioural issues.

Firm specific characteristics play an important role of IPO success as well. Bruton et. al (2010) examine performance effects of ownership concentration in firms that have recently undergone an IPO. They find that concentrated ownership improves IPO performance and show that venture capitalists and business angels have a differential impact on performance. Prior studies show that underwriters reputation (Carter and Manaster, 1990), association with prominent venture capital firms (Gulati and Higgins, 2003) and financial characteristics of companies (Ritter and Welch, 2002) matter for IPO success.

Previous studies about investor IPO participation choices either focus on firm specific characteristics (Bruton et. al (2010), Carter and Manaster (1990), Ritter and Welch (2002)) or focus on private investor specific characteristics (Kaustia and Knüpfer (2008), Kaustia (2004) and Womack (2010)). The focus of our study is to identify investor specific characteristics including educational and demographic characteristics as well as portfolio and trading characteristics that impact participation in IPOs. Given the focus of our study, we use similar approach and control variables as Kaustia and Knüpfer (2008) and do not include company specific variables.

Our study addresses the research question of how comprehensive educational characteristics influence investor choices about participating in IPOs in the stock market by

using a unique dataset from the Estonian stock exchange and combining it with a national education dataset, which includes educational information on those investors.

3. Data and methodology

This section provides detailed information to the dataset and methodology, which is used to solve the unanswered research question how detailed educational characteristics influence investors' IPO participation choices. For this study we use comprehensive dataset from the only stock exchange in Estonia, Tallinn stock exchange, provided by the Nasdaq OMX Tallinn. The data covers the period of nine years starting from 01.01.2004 to 31.12.2012 and includes all transactions made with listed Estonian companies. The period covers transactions for a total of 23 listed companies, which have been traded on the Estonian stock exchange during that period. The Nasdaq OMX Tallinn has a market capitalization of about 2,2 billion euros as of 30.06.2017.

The new IPOs offered during 2004-2012 form 22.1% of the total market capitalisation of the Tallinn stock exchange. The largest company with an IPO during the period market had capitalisation of 183.1 million euros, which was 8.1% of the total market capitalisation at the time. The smallest IPO formed 0.6% of the total market capitalisation. 87.5% of the IPOs were made during the economic growth phase between the years of 2005-2007 when the economy was growing more than 9% annually. Similar "Hot IPO market" periods have been documented in other European and US stock markets as well (Arosio, Giudici, and Paleari, 2001; Ibbotson and Jaffe, 1975; Lowry and Schwert, 2002; and Ibbotson, Sindelar, and Ritter, 1988, 1994).

The total number of different individual investors who have made at least one purchase trade during the sample period is 25,426. The average number of individual investor participating in IPOs during the sample period was 4,641, which is 18.3% of total individual

investors (the largest IPO had 17,114 participants and the least popular 1358 participants who were individual investors).

Besides the data from the Nasdaq OMX Tallinn we use unique dataset from Estonian Ministry of Education and Research, which includes all high school grades and results of high school final exams from their implementation in 1997 till 2012. Descriptive statistics about investors IPO participation together with the educational characteristics is presented in Table 1. Combining those unique datasets allows us to analyse different individual investor types based on a gender, age, portfolio size, average stocks in portfolio, stocks holding period, number of transactions, level of education (high school, bachelor, master, doctor), distribution by type of education (psychology, mathematics, economics, finance, medicine, law, information technology, public administration, chemistry and physics) and high school exam. The total number of the observations of individual investors who we are able to analyse for IPO participation purposes by gender, age, wealth, trading characteristics is 25,426.

The total number of different investors who have made at least one purchase trade during the sample period is 33,843, of which 25,426 are individual investors. Of those investors official educational characteristics for 10,555 investors are obtained and that forms main sample for the analysis. Although the stock market data for the whole population is obtained, it is possible to tie educational data for only those investors whose data are in the educational register, which reduces the sample of the investors. As national state exams and educational register was not present before 1997, the sample consists of quite young investors, with an average age of about 29 years in 2012.

For all investors daily transaction date, the transaction price and the specific stock have been obtained. As investors stock purchasing prices before January 2004 have not been obtained, so the positions opened before that for any of the calculations are not used. Prices

are adjusted for stock splits and dividends. For analysis, binary models and ordinal setup required for the use of different probability models are used. The choice of control variables (such as investor gender, age, portfolio size as a proxy for wealth, experience and trading characteristics) is based on similar works of Kaustia and Knüpfer (2008), Grinblatt, Keloharju, and Linnainmaa (2011), Barber and Odean (2000), Goetzmann and Kumar (2008), Anderson (2007) and Nguyen and Schuessler (2012), who have used similar control variables for IPO and stock market participation analysis and investor financial decision making choices on the stock market. Detailed description and definitions of the control variables is presented in Appendix 1.

Different exam results are analysed individually and in a combined model, because each high school graduate has to take 3-5 state exams to finish the high school. The high school graduate has to take mandatory exams such as mathematics, mother tongue and English or German, while other exams are optional.

Dependence between investors' IPO participation and educational characteristics is analysed by using probit regression models. Due to the dependent binary variable, probit model is most appropriate choice for addressing IPO participation question. For investors' stock market participation probit model has been used by Grinblatt, Keloharju, and Linnainmaa (2011) and by Hong, Kubik, and Stein (2004). Therefore we consider probit model as the appropriate analysis tool to address the IPO participation question. In addition, probit model has been used for similar kind of research by Christiansen, Joensen, and Rangvid (2008), Guiso, Sapienza, and Zingales (2008) and Bogan (2008).

Our models for IPO participation can be described as follows:

$$Investor_i = \beta_0 + \beta_1 * Educational\ characteristic_{ij} + \sum_{k=2}^{k} \beta_k * Controls_{ik} + \epsilon_i$$

where $Investor_i$ is dependent variable for investor *i*, which takes a value 1, if individual *i* has participated in at least one IPO during our sample period and equals 0, if individual has not participated in IPO; $Educational\ characteristic_{ij}$ represents investor *i*'s educational characteristics (national high school exam results, educational level or type) for exams or degree holding *j* and $\sum_{k=2}^{k} \beta_k * Controls_{ik}$ are control variables (gender, age, average stocks in portfolio, total number of transactions, average portfolio size, average holding period and portfolio turnover rate). We are also re-estimating the models using independent variables individually and together with control variables. We also estimate models for logit and OLS regression for robustness test purposes. For easier interpretation of the results we use marginal effect analysis.

Besides IPO participation we also calculate investors' risk-adjusted returns to analyse the financial effect of participating in IPO. Aggregate data is used to have an indicator for the average return during the observed period for investors. As investors can also trade foreign stocks and increase or decrease amount invested, which has an effect to performance, portfolio return is calculated as an annual money-weighted return. Each transaction has been adjusted for transaction costs in amount of five euros + 0.1% * (transaction amount). As discussed by Markowitz (1991) and Modigliani and Modigliani (1997) to have true picture of the investors performance, the risk, which is associated with particular investment, should be taken into account. Therefore each individual's risk-adjusted returns are calculated, because some investors might intentionally take higher risk in order to achieve higher returns.

For the risk-adjusted performance measurement risk-adjusted return is used as described and defined by Modigliani and Modigliani (1997). They have chosen standard deviation as measure of risk, and return as measure of reward, deriving equations accordingly.

4. Empirical results

This section offers empirical results that investors with better results in their high school mathematics exam and investors with no academic degree are less likely to participate in an IPO. We also offer empirical evidence that investors with higher education, a bachelor's degree or a degree in social sciences, economics or public administration are more likely to participate in an IPO. Other findings show that investors with a higher number of transactions and a higher portfolio turnover rate are more likely to participate in an IPO, while older investors tend to participate less in IPOs. By analysing the risk-adjusted performance of the investors, we conclude that investors participating in IPOs earn lower annual risk-adjusted returns than investors who have not participated in IPOs. This finding is in line with the documentation of Ritter (1991), Keloharju (1993) and Schultz (2003).

4.1. Education and IPO participation

We use the probit regression model to test the hypothesis that investors with better high school exam results are more likely to participate in IPOs. In Table 2 we start with the single probit regressions to study the isolated effects of educational variables on IPO participation and then introduce a number of control variables for demographic factors, portfolio diversification, wealth, experience and trading behaviour. Because of the multicollinearity between educational characteristics, the regression models with control variables are analysed individually and are not combined in one model. First we study the mathematics high school exam results with control variables. After that we repeat the probit regression for the other national exam results combined with control variables. The statistical significance of the coefficients of the control variables in the regression results does not differ for different educational characteristics. The results are reported for the national exams and university subjects that are most relevant in terms of the exam participation rate. The results for all the regressions of control variables are available upon request.

The isolated probit regression results in Table 2 show that investors with good exam results in mathematics and English are less likely to participate in IPOs. Both results are statistically significant at the 5% level. Other national high school exam results are statistically not significant for the isolated regression. The result of including different control variables in the probit regressions is that English exam results are statistically not significant and mother tongue exam results turn out to be statistically significant at the 5% level. The mathematics exam results remain statistically significant after control variables are included in the regression. For further interpretation of the results we only use those results that are statistically significant for both regressions.

The results in Table 2 for both the isolated and the combined probit regressions show that only the national high school exam results for mathematics are statistically significant. The coefficient in Table 2 columns one and two for the high school exam results for mathematics indicates a lower probability of someone participating in an IPO if they have better exam results. Analysis of the marginal effect indicates that the probability that they will participate in an IPO decreases by 0.18% for every additional point achieved in the mathematics exam.

Probably one of the key elements present among top performers in math is stronger analytical skills. That can help them to better understand and analyse financial information. Investors with good math skills can make more rational investment decisions, decreasing the emotional component in investment decisions. As previous studies (e.g. by Keloharju, 1993; and Schultz, 2003) show that the long-term performance of IPO stocks underperforms benchmark index returns, it is a rational decision not to participate in an IPO for a long term investor. Similar long term performance metrics apply to the Tallinn stock exchange and are in detailed described in section 4.3.

The same control variables are used in the probit regressions for the analysis of the university degree and level of education as were used for the previous analysis for exam results. We collected all the available data on the types of university degree held by the investors and we generalised and grouped them into different categories by the names of the university courses. The results show that investors with a degree in economics or public administration are more likely to participate in an IPO. The isolated probit regression results in Table 2 indicate that the results for economics and public administration are statistically significant at the 1% level and finance is significant at the 10% level. The combined regression results show that having a degree in economics, information technology or public administration is statistically significant at the 1% level. In the further analysis, only those results that are statistically significant for both regression models are used. The coefficients for economics and public administration indicate that investors with degrees in these subjects are more likely to participate in an IPO. Analysis of the marginal effect reveals that having an economics degree increases the chance of someone participating in an IPO by 7.55% and having a public administration degree increases the likelihood by 11.45%. None of law, physics, medicine, information technology, finance, psychology or any of the natural sciences seem to be statistically significant in the isolated and combined regressions simultaneously.

The results in Table 2 for the level of education reveal that investors with higher education, a bachelor's degree or a degree in social sciences are statistically significant in both the isolated and the combined regression models. The coefficients for those indicate that investors with such degrees are more likely to participate in an IPO. Analysing the results for high school leavers shows that having only a high school leaving diploma is statistically significant for investors in the isolated and combined regression models at the 1% level. The coefficient for investors with only a high school leaving diploma is negative and indicates that those investors are less likely to participate in the IPO. The results of marginal analysis

show that higher education increases the probability that someone will participate in an IPO by 8.79%, having a bachelor's degree increases it by 5.94% and having a social science degree raises it by 5.76%. In contrast, investors with only a high school diploma are 8.79% less likely to participate in an IPO.

There could be several reasons why investors with higher academic degrees participate more actively in IPOs. One reason why investors with degrees in economics and public administration participate more in IPOs might be that they are more aware of the IPOs because the concept of the IPO has been presented to them at university in lectures on finance, and micro and macroeconomics. Christiansen, Joensen, and Rangvid (2008) document that investors with a degree in economics are more likely to participate in the stock market. Our findings show that graduates in economics and public administration are more likely to participate in IPOs, which might be because they are generally more aware of IPOs and the stock market having heard about them in university lectures.

Another reason why investors with degrees in economics and public administration participate more in IPOs might be the expected returns. Derrien (2005) and Arosio, Giudici, and Paleari (2001) find that IPO stocks show excess returns over the benchmark index in the short term, but underperform it in the long term. One possible reason why investors with degrees in economics and public administration participate in IPOs may be that they want to speculate to achieve short-term excess returns. Liivamägi, Vaarmets, and Talpsepp (2014) analyse risk-adjusted returns for those investors and find that investors with higher education or a degree in economics or public administration show better performance in the stock market than investors who do not have such a degree. The desire to earn greater returns might explain the choice to participate in the IPO. As the focus of this study is on the characteristics of the IPO participants, we have not studied the individual trades and risk-adjusted returns for those individual investors.

The overall conclusion is that investors with higher academic education, a bachelor's degree or a degree in social sciences, economics or public administration tend to be more likely to participate in an IPO than investors without those educational characteristics. The opposite is true for investors with no academic degree or with better results in nationally administrated high school mathematics exams, as they are less likely to participate in IPOs. Those findings are unique as such detailed dataset has not been available for previous studies. Nasdaq OMX Tallinn has similar trends in IPO timing compared to the US and other European stock markets and investors have similar trading characteristics as investors in the rest of Europe or the USA (see findings in Liivamägi, 2016). Still, Nasdaq OMX Tallinn is a small stock market with size and liquidity limitations that can affect whether the findings can be generalized for a larger stock markets as well. Despite the limitations of the market, current study uses a unique dataset and offers novel findings that contribute to the existing literature in field of investor IPO participation choices.

4.2. Other factors influencing IPO participation

This section discusses other possible factors that could influence participation in IPOs. We used a number of control variables besides the educational variables to test for the effect of other possible factors on the choice of whether to participate in IPOs. We include continuous control variables such as birth year, total number of transactions, average number of stocks in the portfolio, average portfolio size, average holding period, and portfolio turnover rate in our model.

The results in Table 2 show that the control variable for the average stocks in the portfolio is statistically significant in all the probit regression setups. The positive coefficient indicates that investors holding more diversified stock portfolios are more inclined to participate in IPOs. This finding is quite logical, as investors who want to diversify their

stock portfolio need to search for new stocks. By including more stocks from IPOs in their portfolio, they increase their average number of different stocks.

The positive coefficient for the control variable for portfolio turnover rate suggests that investors with a higher portfolio turnover rate are also more likely to participate in IPOs. The portfolio turnover rate is statistically significant for all the model setups. Barber and Odean (2000) suggest using the portfolio turnover rate as a measure of overconfidence and overtrading. Our results suggest that investors who trade more actively are more willing to participate in IPOs.

The control variable for birth year has a negative coefficient, indicating that IPO participation decreases as age increases. Age is statistically significant in all the model setups at the 1% level. Age could be seen as a proxy for investor experience and the results indicate that investors with more experience are more reluctant to participate in IPOs as they might have had negative experiences with earlier IPOs. This finding is in line with the conclusion of Kaustia and Knüpfer (2008), who argue that investors learn from their past experience when they participate in IPOs. Gender, the total number of transactions and wealth are not statistically significant for the model setups and so no conclusions can be drawn for those variables.

4.3. IPO investors performance analysis

This section offers an insight into the performance of investors who participated in an IPO. Prior studies by Keloharju (1993) and Schultz (2003) suggest that the long-term performance of IPO stocks is worse than that of a benchmark index.

During the period observed from 01.01.2004 to 31.12.2012, investors were able to participate in eight different IPOs, which is a relatively high number given there were a total of 23 different stocks listed for trading during the period. The descriptive statistics for the IPOs with the number of investors participating and the short and long-term returns relative

to the OMXT benchmark index are presented in Table 3. In total 22,831 investors participated in at least one IPO during the period observed, giving a participation rate of 67.46% of total investors. The most popular IPO was Tallink Group with 17,114 individual investors, followed by the Ekspress Group and Olympic Entertainment Group IPOs with 5,960 and 4,566 investors.

Table 3 shows the one-month, one-year and five-year IPO stock returns relative to the OMXT benchmark index. Only two stocks proved able to outperform the OMXT benchmark index in the long run. Starman demonstrated a cumulative excess return of 118.05% over the OMXT index return from 28.06.2005 to 31.03.2009, when the company left the stock exchange, and Tallinna Vesi demonstrated an excess return of 43.33% over the benchmark index return five years after its IPO. The stock returns of the other six companies underperformed the benchmark index in a five year period. About half of the companies were able to demonstrate positive returns over the benchmark index in one month and in one year. Those results are in line with the findings of Keloharju (1993) and Schultz (2003), who show that investors who participate in IPOs show poor performance results in the long run.

Table 4 reports the annual risk-adjusted performance in the stock market of investors who participated in the IPOs compared to that of investors who did not participate. Ordered logit regression was used for the analysis as suggested by Greene (1997) and van Dijk and Pellenbarg (2000). The ordered logit regression results show a negative coefficient for investors who participated in the IPOs, indicating that those investors achieve lower annual risk-adjusted returns in the stock market. The results are statistically significant at the 1% level. The opposite is true for investors who did not participate in the IPOs as they have a positive regression coefficient. The annual risk-adjusted return for investors who participate

in an IPO is 0.44% for the 50th percentile and that for the investors who did not participate is 2.78%.

The marginal analysis presented in Table 4 Panel B reports the results for a discrete change in the dummy variable from 0 to 1 if the investor participated in an IPO. The results indicate that the probability of the investor being in the highest risk-adjusted return group decreases by 2.48% if the investor participated in an IPO and the probability of the investor being in the lowest risk-adjusted return group increases by 2.39% if the investor participated in an IPO. All marginal analysis results are statistically significant at the 1% level. These findings are in line with the results of Keloharju (1993) and Schultz (2003), who suggest that the long-term performance of IPO stocks underperforms benchmark index returns.

4.4. Robustness tests

A number of additional tests were made to verify the robustness of our results. The logit regression models for the isolated and combined models with control variables were estimated. The results of those tests confirmed the findings from the probit model presented in Table 2. Those results are available upon request. In addition, we used OLS regressions (see Table 5) instead of probit regressions, although probit should be preferred for the task. The results of the OLS regressions with control variables confirm the results presented in Table 2. We derived control variables such as gender, age, wealth, experience and trading characteristics for the empirical model following the documentation of previous studies. Detailed descriptions and definitions of the control variables is presented in Appendix 1.

The robustness test results reported in Table 5 confirm the findings from Table 2 that investors with higher academic education, a bachelor's degree or a degree in social sciences, economics or public administration tend to participate more in IPOs than investors who do

not have these educational characteristics. The educational characteristics mentioned are statistically significant in the isolated and the combined regression results and all the coefficients are positive, confirming that those investors are more likely to participate in an IPO. The opposite is true for investors with no academic degree and better results in nationally administrated high school exams in mathematics, as they are less likely to participate in IPOs. The educational characteristics mentioned are statistically significant in the isolated and the combined regression results and all the coefficients are negative, indicating a lower probability of participation in an IPO.

5. Conclusion

Several authors have concluded that education is a key characteristic in determining the behaviour of investors and their financial decisions in the stock market. Investors with a higher level of education are more likely to participate in the stock market (Campbell (2006)), take more risks (Grable (1998)) and hold more diversified portfolios (Goetzmann and Kumar (2008)).

The main contribution of the paper is the first empirical documentation of the comprehensive educational characteristics that influence investor participation in IPOs in the stock market. In this paper we offer supporting evidence for our hypothesis that investors with higher education, a bachelor's degree or a degree in social sciences, economics or public administration are more likely to participate in an IPO. A possible reason why investors with degrees in economics and public administration participate more in IPOs might be the expected short-term returns. Arosio, Giudici, and Paleari (2001) find that IPO stocks show excess returns over a benchmark index in the short term, but in the long term they underperform the benchmark index. The desire to earn greater returns might explain why investors with higher education, or with a degree in economics or public administration are more likely to participate in IPOs.

In addition, we reject the hypothesis that investors with better high school exam results in mathematics are more likely to participate in IPOs as our empirical results suggest the opposite, indicating that those investors are more likely not to participate in IPOs. Analysing the performance of investors who participate in IPOs reveals that they achieve lower risk-adjusted returns on the stock market than investors who do not participate. This finding is in line with the documentation of Keloharju (1993) and Schultz (2003), who show that the long-term performance of IPO stocks is below the returns of the market benchmark index.

Our other findings suggest that investors with a higher number of transactions tend to hold more stocks in their portfolio and are more likely to participate in an IPO. Additionally, we note that investors with a higher portfolio turnover rate are also more likely to participate in IPOs. Age has a negative influence on IPO participation, indicating that IPO participation decreases as age increases. No conclusion about other demographic and trading characteristics can be drawn from the analysis.

Having confirmed that investors with higher education, a bachelor's degree or a degree in social sciences, economics or public administration are more likely to participate in an IPO, it would be interesting to study how long they hold their IPO stocks for and what their risk-adjusted performance is, to see whether they time their stock sales better.

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Table 1. Investor education and IPO participation

Independent variable	Observations	Mean	Std. Dev.	Min	Max	Participated on the IPO	Participation rate
English exam results	5449	71.27	16.79	0	100	3728	68%
Geography exam results	1223	69.12	13.98	21	98	772	63%
History exam results	2600	60.80	19.05	6	97	1841	71%
Math exam results	4648	56.37	25.38	0	100	3133	67%
Mother tongue results	6438	61.70	20.47	0	100	4287	67%
Physics exam results	866	64.68	22.98	8	100	588	68%
Higher education	10555	0.79	0.41	0	1	5971	72%
Master's or doctoral degree	10555	0.06	0.23	0	1	431	71%
Bachelor or equivalent degree	10555	0.59	0.49	0	1	4478	72%
High school graduate	10555	0.21	0.41	0	1	1415	63%
Natural sciences degree	10555	0.12	0.32	0	1	874	70%
Humanities degree	10555	0.05	0.22	0	1	372	70%
Social science degree	10555	0.49	0.50	0	1	3743	73%
Degree in economics	10555	0.24	0.43	0	1	1903	76%
Degree in public administration	10555	0.02	0.14	0	1	160	81%
Degree in finance	10555	0.02	0.15	0	1	173	75%
Degree in information technology	10555	0.07	0.25	0	1	484	68%
Degree in math or statistics	10555	0.00	0.06	0	1	25	69%
Degree in physics, chemistry or biology	10555	0.01	0.11	0	1	89	71%
Degree in law	10555	0.05	0.21	0	1	367	73%
Degree in medicine	10555	0.02	0.13	0	1	110	65%
Degree in psychology	10555	0.01	0.09	0	1	55	69%
Male	33843	0.57	0.50	0	1	13324	69%
Female	33843	0.25	0.44	0	1	5399	63%
Birth year	28469	1967.36	17.09	1906	2011		
Average stocks in portfolio	25426	1.94	1.40	1	17		
Total number of transactions	28002	18.45	167.58	0	16599		

Average portfolio size	33843	17226.93	877573.9	0	15213924
Average holding period	33843	183.81	289.11	0	1964
Portfolio turnover rate	25426	8.38	81.46	1	7532

Note: Table 1 reports independent variable descriptive statistics by the following educational categories: national high school exam results, level and type of education. Table reports number of observations, mean, standard deviation, minimum and maximum for investors'. In addition, table reports for each educational characteristic a number of investors participated on the IPO and the participation rate for those investors based on the educational group total population.

Source: Author´s calculations

Table 2. Probit regression model for investors IPO participation and educational characteristics

Independent variables	Individual variables for IPO participation		High school exam results and control variables		Educational level and control variables		Education type and control variables	
	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Math exam results	-0.002**	-2.31	-0.002*	-1.83				
Physics exam results	0.001	0.34	-0.001	-0.43				
Mother tongue results	0.001	0.99	0.002**	2.05				
English exam results	-0.002**	-2.00	0.000	0.34				
History exam results	0.001	0.56	0.001	0.57				
Geography exam results	0.000	-0.16	-0.003	-0.78				
Higher education	0.245***	7.98			0.130***	3.21		
Master's or doctoral degree	0.028	0.51			-0.085	-1.01		
Bachelor or equivalent degree	0.170***	6.54			0.113***	3.40		
High school graduate	-0.245***	-7.98			-0.130***	-3.21		
Natural sciences degree	0.009	0.23			-0.013	-0.24		
Humanities degree	0.010	0.18			0.014	0.17		
Social science degree	0.166***	6.45			0.102***	2.99		
Degree in economics	0.225***	7.26					0.182***	4.44
Degree in public administration	0.368***	3.54					0.359***	2.65
Degree in finance	0.161*	1.77					0.067	0.56
Degree in information technology	-0.072	-1.43					-0.169***	-2.69
Degree in math or statistics	-0.015	-0.07					0.117	0.41
Degree in physics, chemistry, biology	0.019	0.16					-0.008	-0.05
Degree in law	0.097	1.58					0.093	1.17
Degree in medicine	-0.138	-1.38					-0.097	-0.73
Degree in psychology	-0.035	-0.24					0.036	0.17
Male			0.044	0.70	-0.067*	-1.72	-0.062	-1.57
Birth year			-0.034***	-4.88	-0.020***	-7.24	-0.021***	-7.62

Average stocks in portfolio	0.116***	3.52	0.132***	6.02	0.134***	6.08
Total number of transactions	0.008	1.11	0.007	1.53	0.008	1.75
Average portfolio size	0.000	-0.10	0.000	0.43	0.000	0.25
Average holding period	0.000***	3.59	0.000**	2.38	0.000*	2.43
Portfolio turnover rate	0.078***	4.92	0.053***	5.10	0.052**	4.93
Log likelihood	-1876		-3954		-3949	
Pseudo R^2	0.10		0.09		0.09	

Note: Table 2 reports coefficients and z-values from a probit regression with robust standard errors in which the dependent variable takes the value 0 or 1, depending on the IPO participation. In the first column independent dummy variables are presented. In the other columns multiple regression results are presented. Because of the multicollinearity the second, third and fourth column regressions are run individually together with the control variables. In this table control variables coefficients for second column are presented for math exam results, for third column higher education and for forth column investors holding a degree in economics. Other regressions control variables coefficients statistical significance does not differ and are available based upon request. Coefficients denoted with *, ** and *** are respectively significant at the 10%, 5% and 1% level.

Source: Author´s calculations

Table 3. Tallinn stock exchange IPO short and long term performance

Company	Investors	Share price	First trading date	Volume	1 month return to OMXT	1 year return to OMXT	5 year return to OMXT
Tallinna Vesi	2452	9,25	1.06.2005	55,50	6,76%	41.55%	43.33%
Starman*	1777	3,35	28.06.2005	12,16			
Tallink Grupp	17114	5,27	9.12.2005	183,13	-9,50%	-38,45%	-43,70%
Nordecon	2070	5,75	18.05.2006	18,85	7,72%	88.50%	-67.43%
Olympic Entertainment Group	4566	4,67	23.10.2006	71,85	16,92%	98.69%	-30.75%
Ekspress Grupp	5960	5,90	5.04.2007	36,10	-7.93%	-19.77%	-49.27%
Arco Vara	1834	2,43	21.06.2007	96,78	-12.13%	-33.22%	-61.72%
Premia Foods	1358	0,89	5.05.2010	12,97	2.9%	-20.77%	-57.23%

Note: Table 3 reports all listed IPOs during the period of 1st of January 2004 until 31st of December 2012. Table reports number of investors participated on the IPO, share price in euros, first trading date, IPO volume in millions of euros, one month stock return compared to Nasdaq OMXT benchmark index return and one and five year returns compared to Nasdaq OMXT benchmark index return. Stock returns have been adjusted for dividends and stock splits.

*Starman left Nasdaq OMX Tallinn stock exchange on 31.03.2009. Starman demonstrated 118,05% excess return compared to the OMXT index return during the period of 28.06.2005 until 31.03.2009.

Source: The NASDAQ OMX Group web page: http://www.nasdaqomxbaltic.com/market/

Table 4. Investors IPO participation and risk-adjusted returns

Panel A. Investors' portfolio risk-adjusted returns							
	Investors portfolio risk-adjusted return						
	Percentiles						
Independent variables	10%	25%	50%	75%	90%	Coefficient	z-value
Participated on IPO	-17,19%	-6,40%	0,44%	12,34%	37,60%	-0,13***	-4,87
No participation on IPO	-23,96%	-9,78%	2,78%	19,82%	62,79%	0,13***	4,87

Panel B. Marginal analysis								
Independent variables	I Quartile		II Quartile		III Quartile		IV Quartile	
	Coefficients	z-values	Coefficients	z-values	Coefficients	z-values	Coefficients	z-values
IPO participation	2,39%***	4,97	0,86%***	4,62	-0,77%***	-5,15	-2,48%***	-4,79

Note: Table 4 Panel A reports investors annual risk-adjusted performance on the stock market for investors participated in the IPOs and for investors who have not participated in the IPOs. Table reports coefficients and z-values from an ordered logit regression with robust standard errors in which the categorical dependent variable takes the value 1 to 4, depending on investors' risk-adjusted performance. Panel B reports coefficient probabilities and z-values from an ordered logit regression marginal analysis for the discrete change in dummy variable from 0 to 1, if investor has participated on the IPO. The quartile I represents the lowest and the quartile IV the highest category for investor risk-adjusted performance. Coefficients denoted with *, ** and *** are respectively significant at the 10%, 5% and 1% level.

Source: Author´s calculations

Table 5. OLS regression results for investor IPO participation and educational characteristics

Independent variables	Individual variables for IPO participation		High school exam results and control variables		Educational level and control variables		Education type and control variables	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Math exam results	-0.001**	-2.31	-0.001*	-1.76				
Physics exam results	0.000	0.34	0.000	-0.64				
Mother tongue results	0.000	0.99	0.001**	2.06				
English exam results	-0.001**	-2.00	0.000	0.05				
History exam results	0.000	0.56	0.000	0.86				
Geography exam results	0.000	-0.16	-0.001	-0.56				
Higher education	0.088***	8.08			0.051***	4.34		
Master's or doctoral degree	0.010	0.51			-0.022	-1.00		
Bachelor or equivalent degree	0.059***	6.57			0.038***	4.15		
High school graduate	-0.088***	-8.08			-0.051***	-4.34		
Natural sciences degree	0.003	0.23			0.002	0.12		
Humanities degree	0.004	0.18			0.002	0.07		
Social science degree	0.058***	6.46			0.033***	3.55		
Degree in economics	0.075***	7.22					0.048***	4.40
Degree in public administration	0.115***	3.48					0.083**	2.54
Degree in finance	0.054*	1.75					0.016	0.51
Degree in information technology	-0.026	-1.44					-0.044**	-2.49
Degree in math or statistics	-0.005	-0.07					0.037	0.49
Degree in physics chemistry or biology	0.007	0.16					0.006	0.16
Degree in law	0.033	1.57					0.024	1.15
Degree in medicine	-0.050	-1.40					-0.029	-0.75
Degree in psychology	-0.012	-0.24					0.024	0.44
Male			0.036*	1.87	-0.004	-0.32	-0.003	-0.24
Birth year			-0.010***	-4.96	-0.005***	-7.33	-0.006***	-8.06

Average stocks in portfolio	0.058***	7.81	0.051***	11.57	0.052***	11.73
Total number of transactions	0.001	0.83	0.000	0.70	0.001	0.95
Average portfolio size	0.000	0.62	0.000	1.29	0.000	1.09
Average holding period	0.000*	1.82	0.000	0.11	0.000	0.16
Portfolio turnover rate	0.001	0.23	0.000	0.28	0.000	0.05
Number of observations	3706		8162		8162	
Adjusted R-squared	0.057		0.050		0.050	

Note: Table 5 reports coefficients and t-values from a OLS regression with robust standard errors in which the dependent variable takes the value 0 or 1, depending on the IPO participation. In the first column independent dummy variables are presented. In the other columns multiple regression results are presented. Because of the multicollinearity the second, third and fourth column regressions are run individually together with control variables. In this table control variables coefficients for second column are presented for math exam results, for third column higher education and for forth column investors holding a degree in economics. Other regressions control variables coefficients statistical significance does not differ and are available based upon request. Coefficients denoted with *, ** and *** are respectively significant at the 10%, 5% and 1% level.

Source: Author´s calculations

Appendix 1. Description and definition of control variables

Control variable	Definition	Sources from previous studies
Male	Dummy variable for gender. The binary dummy variable is 1 if investor gender is male and 0 if investor gender is female.	Kaustia and Knüpfer (2008) use gender as a control variable in their study about investors IPO participation choices. In addition, Grinblatt, Keloharju, and Linnainmaa (2011) use gender as a control variable in their study about investors stock market participation choices. Barber and Odean (2000) use gender as a control variable in their study about investors financial decision on the stock market.
Birth year	Variable based on the birth year of the investor.	Kaustia and Knüpfer (2008) use age as a control variable in their study about investors IPO participation choices. Barber and Odean (2000) use gender as a control variable in their study about investors financial decision on the stock market.
Average stocks in portfolio	The variable shows how many stock the investor has in the portfolio.	Kaustia and Knüpfer (2008) use the number of stocks in investor's portfolio as a control variable in their study about investors IPO participation choices. Goetzmann and Kumar (2008) use the number of stocks in investor's portfolio as a proxy for portfolio diversification. Anderson (2007) uses the average number of stocks in portfolio as a measure for investor portfolio diversification and analyses the effect of diversification and financial decisions on the stock market.
Total number of transactions	The variable shows how many transactions the investor has made during the sample period.	Kaustia and Knüpfer (2008) use the number of stock transactions as a control variable in their study about investors IPO participation choices. Nguyen and Schuessler (2012) use the number of trades as a proxy for investors' trading activity and trading experience and use

		this variable in their study about investors financial decision on the stock market.
Average portfolio size	The variable shows the average monetary portfolio size in euros for the investor.	Kaustia and Knüpfer (2008) use portfolio size as a control variable in their study about investors IPO participation choices. In addition, Grinblatt, Keloharju, and Linnainmaa (2011) use portfolio size as a control variable in their study about investors stock market participation choices.
Average holding period	The variable shows the average holding period that the investor has held stocks in the portfolio.	Barber and Odean (2001) define average stock holding period as a proxy for investor trading characteristic and use it in their study about investors financial decision on the stock market.
Portfolio turnover rate	The variable shows the investor's portfolio turnover rate, i.e. how much the investor trades and how fast the stock in the portfolio changes.	Barber and Odean (2000) and Anderson (2007) use the portfolio turnover rate as a measure of overconfidence and overtrading and use it in their study about investors financial decision on the stock market.

Note: Appendix 1 reports control variables definitions and descriptions used in regression analysis. In addition, the table reports sources from previous studies and motivation to use such control variables in this study

Source: Author´s table

CURRICULUM VITAE

1. Personal data

Name	Kristjan Liivamägi
Date and place of birth	16.06.1986, Tallinn
Citizenship	Estonian
Family status	Married, one child (born 2016)
E-mail address	kristjan.liivamagi@gmail.com

2. Education

Educational institution	Graduation year	Education (Field of study/degree)
Tallinn University of Technology	(2018)	Financial economics / Doctor of Philosophy
Tallinn University of Technology	2010	Economics / Master of Arts
Tallinn University of Technology	2008	Logistics / Bachelor of Arts
Dresden University of Technology	2008	BA studies in Logistics

3. Language competence/skills (fluent, average, basic skills)

Language	Level
Estonian	Native
English	Fluent
German	Fluent
Russian	Basic skills
Finnish	Basic skills

4. Special courses

Period	Course	Educational or other organisation
2013 – 2016	Certified Estonian Auditor courses on finance, taxes, accounting and auditing	The Estonian Board of Auditors
2013 – 2014	Nine exams and courses to pass Certified Estonian Auditor and Certified Estonian Public Auditor exams	Ministry of Finance
2009 – 2015	Accounting and audit methodology (Riga) Project management (Amsterdam) Financial sector audit methodology (Riga) Financial sector trends and future technologies (Copenhagen) IFRS and audit planning (Druskininkai)	Ernst & Young Baltic AS

5. Professional employment

Period	Organisation	Position
2017 - …	Tallinn University of Technology	Lecturer, Department of Economics and Finance
2015 - ...	Tallinn City Office	Leading Treasury Specialist
2014 - ...	Estonian Entrepreneurship University of Applied Sciences	Lecturer, Department of Entrepreneurship
2013 - 2016	Tallinn University of Technology	Lecturer, Department of Economics and Finance, Chair of Finance and Banking
2014 - 2015	Ernst & Young Baltic AS	Certified Estonian Auditor, manager
2013 - 2015	Tallinn University	Visiting Lecturer
2011 - 2014	Ernst & Young Baltic AS	Senior consultant
2009 - 2011	Ernst & Young Baltic AS	Consultant

6. Research activity, including honours and theses supervised

2017 - Nominee for the “Lecturer of the year”. Estonian Ministry of Education and Research.
2016 - Bank of Estonia research award for article "How Does Learning and Education Help to Overcome the Disposition Effect" (co-authors Tarvo Vaarmets and Tõnn Talpsepp)
2016 - Tiina Mõis doctoral Scholarship for outstanding academic contribution in doctoral studies.
2016 - Jaan Poska Scholarship for outstanding academic results.
2015 - Kristjan Jaak scholarship for article "The Brilliant Mind of Investors" presentation in World Finance Conference, Buenos Aires, Argentina on July 21-24, 2015.
2014 - Bank of Estonia research award for article "The Brilliant Mind of Investors" (co-authors Tarvo Vaarmets and Tõnn Talpsepp)
2014 - Kristjan Jaak scholarship for article "Masters of the Stock Market" presentation in INFINITI Conference on International Finance, Prato, Italy, 9-10 June 2014.

Publications

Liivamägi, Kristjan, Vaarmets, Tarvo, and Talpsepp Tõnn (2018). Investor Education and IPO Participation. *Emerging Markets Finance and Trade*, forthcoming. DOI: https://doi.org/10.1080/1540496X.2018.1443806. (ETIS 1.1)

Vaarmets, Tarvo, Liivamägi, Kristjan, and Talpsepp Tõnn (2016). How Does Learning and Education Help to Overcome the Disposition Effect? *Review of Finance*, forthcoming (ETIS 1.1)

Liivamägi, Kristjan (2016). Investor Education and Trading Activity on the Stock Market. *Baltic Journal of Economics*, vol. 16, no. 2, pp. 114-131. DOI: dx.doi.org/10.1080/1406099X.2016.1189058. (ETIS 1.1)

Liivamägi, Kristjan (2015). Investor Education and Portfolio Diversification on the Stock Market. *Research in Economics and Business: Central and Eastern Europe*, vol. 7, no. 1, pp. 23−42. (ETIS 1.2).

Working Papers

Liivamägi, Kristjan, Vaarmets, Tarvo, and Talpsepp Tõnn (2014). Masters of the stock market. *TUT Economic Research Series,* 1−27.

Vaarmets, Tarvo, Liivamägi, Kristjan, and Talpsepp Tõnn (2014). The brilliant mind of investors. *TUT Economic Research Series*, 1−28.

Conference presentations / Conference proceedings

Liivamägi, K., Vaarmets, T., Talpsepp, T., 2014. *Masters of the stock market*, INFINITI 2014 Conference. INFINITI Conference on international finance, Prato, Italy, 9-10 June 2014. (ETIS 5.2).

Liivamägi, K., Vaarmets, T., Talpsepp, T., 2014. *Masters of the stock market*. The 6th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 15-17 June 2014, Tallinn: Tallinn University of Technology. (ETIS 3.4).

Liivamägi, K., 2015. *Investor Education and Portfolio Diversification on the Stock Market*. 7th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 14-16 June 2015, Tallinn: Tallinn University of Technology. (ETIS 3.4).

Liivamägi, K., Vaarmets, T., Talpsepp, T., (2015). *Investor Education and Risk Taking Behaviour in the Stock Market*. 7th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 14-16 June 2015, Tallinn: Tallinn University of Technology. (ETIS 3.4).

Liivamägi, K. 2016. *Investor Education and Portfolio Diversification on the Stock Market*. World Finance & Banking Symposium, 14-15 December 2016, Dubai, United Arab Emirates. (ETIS 5.2).

Liivamägi, K., 2016. *Investor Education and Trading Activity on the Stock Market*. 8th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 19-21 June 2016, Tallinn: Tallinn University of Technology. (ETIS 3.4).

Teaching

Finance decisions, Bachelor course
Basics of finance, Bachelor course
Personal finance, Bachelor course
Financial management, Master course
Management economics, Master course
Global economy and financial markets, Master course

7. Theses defended

Relative importance of gold in private investors' portfolio, Master Thesis, supervisor Ivo Karilaid, Tallinn University of Technology

Comparison between public transportation in Dresden and Tallinn, Bachelor Thesis, supervisor Ene-Mall Villemi, Tallinn University of Technology

8. Main research topics

Behavioural finance, portfolio diversification, investment decisions, education

9. Additional information

2014 – Estonian Certified Public Auditor; The Estonian Board of Auditors
2013 – Estonian Certified Auditor; The Estonian Board of Auditors
2012 – Member of the work group of doctoral studies at TSEBA

ELULOOKIRJELDUS

1. Isikuandmed

Ees- ja perekonnanimi	Kristjan Liivamägi
Sünniaeg ja –koht	16.06.1986, Tallinn
Kodakondsus	Eesti
Perekonnaseis	Abielus, üks laps (sünd. 2016)
E-posti aadress	kristjan.liivamagi@gmail.com

2. Hariduskäik

Õppeasutus (nimetus lõpetamise ajal)	Lõpetamise aeg	Haridus (eriala/kraad)
Tallinna Tehnikaülikool	(2018)	Finantsökonoomika / doktor
Tallinna Tehnikaülikool	2010	Rahvamajandus / teadusmagister
Tallinna Tehnikaülikool	2008	Logistika, bakalaureus
Dresdeni Tehnikaülikool	2008	Logistika, bakalaureuseõpingud ERASMUS stipendiaadina

3. Keelteoskus (alg-, kesk- või kõrgtase)

Keel	Tase
Eesti keel	Emakeel
Inglise keel	Kõrgtase
Saksa keel	Kõrgtase
Vene keel	Algtase
Soome keel	Algtase

4. Täiendusõpe

Õppimise aeg	Täiendusõpe	Täiendusõppe korraldaja nimetus
2013 – 2016	Vandeaudiitori kursused finants, maksunduse, raamatupidamise ja auditi alal	Audiitorkogu
2013 – 2014	Vandeaudiitori kutsetunnistuse üheksa eksamit ja kursust	Rahandusministeerium
2009 – 2015	Raamatupidamine ja auditi metodoloogia (Riia) Projektijuhtimine (Amsterdam) Finantssektori auditi metodoloogia (Riia) Finantssektori trendid ja tulevikutehnoloogiad (Kopenhaagen) IFRS ja auditi planeerimine (Druskininkai)	Ernst & Young Baltic AS

5. Teenistuskäik

Töötamise aeg	Tööandja nimetus	Ametikoht
2017 - …	Tallinna Tehnikaülikool	Lektor, Majandusanalüüsi ja rahanduse instituut
2015 - ...	Tallinna Linnakantselei	Juhtivspetsialist linnakassa osakonnas
2014 - ...	Eesti Ettevõtluskõrgkool Mainor	Lektor, Ettevõtluse õppetool
2013 - 2016	Tallinna Tehnikaülikool	Lektor, Majandusanalüüsi ja rahanduse instituut, panganduse ja rahanduse õppetool
2014 - 2015	Ernst & Young Baltic AS	Vandeaudiitor, auditiosakonna juhtivkonsultant
2013 - 2015	Tallinna Ülikool	Erakorraline lektor
2011 - 2014	Ernst & Young Baltic AS	Auditiosakonna vanemkonsultant
2009 – 2011	Ernst & Young Baltic AS	Auditiosakonna konsultant

6. Teadustegevus, sh tunnustused ja juhendatud lõputööd

2017 - Aasta õppejõu nominent. Haridus- ja Teadusministeerium.
2016 - TTÜ Arengufondi Tiina Mõisa nimeline doktoriõppe stipendium doktoriõpingute jaoks.
2016 - Jaan Poska nimeline stipendium silmapaistvate õpitulemuste eest.
2015 - Kristjan Jaagu stipendium artikli "*The Brilliant Mind of Investors*" ettekandeks konverentsil World Finance Conference, Buenos Aires, Argentiina 21-24 juuli, 2015.
2014 – Eesti Panga teaduspreemia artikli "*The Brilliant Mind of Investors*" eest (kaasautorid Tarvo Vaarmets ja Tõnn Talpsepp)
2014 - Kristjan Jaagu stipendium artikli "*Masters of the Stock Market*" ettekandeks konverentsil INFINITI Conference on International Finance, Prato, Itaalia, 9-10 juuni 2014.

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Liivamägi, Kristjan, Vaarmets, Tarvo, and Talpsepp Tõnn (2018). "Investori haridus ja aktsiate esmasel avalikul pakkumisel osalemine". *Emerging Markets Finance and Trade*, ilmumas.
DOI: https://doi.org/10.1080/1540496X.2018.1443806. (ETIS 1.1)

Vaarmets, Tarvo, Liivamägi, Kristjan, and Talpsepp Tõnn (2016). "Kuidas aitab õppimine ja haridus vältida dispositsiooniefekti?" *Review of Finance*, ilmumas (ETIS 1.1)

Liivamägi, Kristjan (2016). "Investori haridus ja kauplemisaktiivsus aktsiaturul". *Baltic Journal of Economics*, vol. 16, no. 2, pp. 114-131. DOI: dx.doi.org/10.1080/1406099X.2016.1189058. (ETIS 1.1)

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Toimetised

Liivamägi, Kristjan, Vaarmets, Tarvo, and Talpsepp Tõnn (2014). “Finantsturgude meistrid”. *TUT Economic Research Series,* 1−27.

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Konverentsiettekanded / eelpublitseerimine konverentsimaterjalidena

Liivamägi, K., Vaarmets, T., Talpsepp, T., 2014. *Finantsturgude meistrid*, INFINITI 2014 Conference. INFINITI Conference on international finance, Prato, Italy, 9-10 June 2014. (ETIS 5.2).

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Liivamägi, K., 2015. *Investori haridus ja portfelli hajutamine aktsiaturul*. 7th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 14-16 June 2015, Tallinn: Tallinn University of Technology. (ETIS 3.4).

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Liivamägi, K. 2016. *Investori haridus ja portfelli hajutamine aktsiaturul*. World Finance & Banking Symposium, 14-15 December 2016, Dubai, United Arab Emirates. (ETIS 5.2).

Liivamägi, K., 2016. *Investori haridus ja kauplemisaktiivsus aktsiaturul*. 8th International Conference "Economic Challenges in Enlarged Europe", Conference Proceedings, 19-21 June 2016, Tallinn: Tallinn University of Technology. (ETIS 3.4).

Õppetöö

Rahanduse otsused, bakalaureuseõpe
Rahanduse alused, bakalaureuseõpe
Eraisiku rahandus, bakalaureuseõpe
Finantsjuhtimine, magistriõpe
Juhtimisökonoomika, magistriõpe
Globaalne majandus ja finantsturud, magistriõpe

7. Kaitstud lõputööd

Kulla optimaalne osakaal erainvestori portfellis, magistritöö, juhendaja Ivo Karilaid, Tallinna Tehnikaülikool

Tallinna ja Dresdeni ühistranspordi võrdlus, bakalaureusetöö, juhendaja Ene-Mall Villemi, Tallinna Tehnikaülikool

8. Teadustöö põhisuunad

Käitumuslik rahandus, portfelli hajutamine, investeerimisotsused, haridus

9. Lisainfo

2014 – Avaliku sektori vandeaudiitor; Audiitorkogu
2013 – Vandeaudiitor; Audiitorkogu
2012 - Majanduse doktoriõppe töörühma liige